EE/CA Report
Public Review Draft

Port of Portland
Portland, Oregon

May 31, 2005

BLASLAND, BOUCK & LEE, INC.
engineers, scientists, economists

EE/CA Report
Public Review Draft

Respectfully submitted,

BLASLAND, BOUCK & LEE, INC.

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List of Acronyms

AOC	Administrative Order on Consent for Removal Action
ARAR	applicable or relevant and appropriate requirement
AST	aboveground storage tank
BEBRA	bank excavation and backfill remedial action
BSAF	biota-sediment accumulation factor
CDF	confined disposal facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COI	chemical of interest
COPC	chemical of potential concern
CSM	conceptual site model
CWA	Clean Water Act
cy	cubic yard
cy/hr	cubic yards per hour
DEQ	Oregon Department of Environmental Quality
DQO	data quality objective
DSL	Oregon Department of State Lands
EE/CA	engineering evaluation/cost analysis
ESA	Endangered Species Act
EU	exposure unit
FEMA	Federal Emergency Management Agency
HASP	health and safety plan
HQ	hazard quotient
IRM	International Raw Materials
KMBT	Kinder Morgan Bulk Terminals
LNAPL	light nonaqueous-phase liquid
LOAEL	lowest-observed-adverse-effects level
µg/kg	micrograms per kilogram
MNR	monitored natural recovery
NAPL	nonaqueous-phase liquid
NAVFAC	Naval Facilities Engineering Command
NCP	National Contingency Plan
NJDOT/OMR	New Jersey Department of Transportation’s Office of Maritime Resources
NOAEL	no-observed-adverse-effects level
NPL	National Priorities List
NPV	Net Present Value
NTCRA	Non-Time-Critical Removal Action
OHW	ordinary high water
O&M	operations and maintenance
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEC	probable effects concentration
PPE	personal protective equipment
PRP	potentially responsible party

PRSC	post-removal site control
RAO	Removal Action Objective
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI/FS	remedial investigation/feasibility study
ROD	Record of Decision
SOW	statement of work
TBC	to be considered
TCLT	thin-column leaching test
TCLP	toxicity characteristics leaching procedure
TEC	threshold effects concentration
TRV	toxicity reference value
TSD	treatment, storage, and disposal
UCL95	95% upper confidence limit
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
UST	underground storage tank

Executive Summary

Background

In 2000, the U.S. Environmental Protection Agency (USEPA) added the Portland Harbor Superfund Site to the National Priorities List. In fall 2001, the USEPA and ten of the Superfund Site's potentially responsible parties entered into an Administrative Order on Consent for a Remedial Investigation/Feasibility Study of the Superfund Site. The Administrative Order on Consent allows Early Actions to be conducted to address known contamination at specific locations within the Superfund Site. Contaminants found in Terminal 4 sediment samples during a remedial investigation directed by the Oregon Department of Environmental Quality (DEQ) led to a determination that a Removal Action at Terminal 4 is warranted. Accordingly, the Port of Portland (Port) is conducting a Non-Time-Critical Removal Action (NTCRA) under an Administrative Order on Consent for Removal Action (the AOC) executed by the Port and USEPA in October 2003.

The AOC requires the Port to conduct an engineering evaluation and cost analysis (EE/CA) for the Terminal 4 Removal Action in which various Removal Action alternatives are identified, compared, and ranked for their relative performance at meeting specific objectives associated with the evaluation criteria of effectiveness, implementability, and cost. An evaluation of the existing data identified a number of data gaps associated with the characteristics of the Removal Action Area and with the impact of those characteristics on the identification and evaluation of Removal Action alternatives. A field characterization effort was therefore designed to gather specific information regarding the physical, engineering, hydrogeologic, sediment quality, dredged sediment quality, and hydraulics and sedimentation characteristics of the Removal Action Area. This field effort was performed during May through September 2004. Following completion of the field and laboratory activities associated with the characterization effort, a characterization report (BBL, 2004b) was prepared and submitted to the USEPA.

Based on the available characterization data, including the newly collected data presented in the characterization report (BBL, 2004b), the Port evaluated potentially applicable technologies that would be considered for inclusion in the development of Removal Action alternatives. In accordance with the AOC, the feasible and implementable technologies and a suite of Removal Action alternatives that incorporate the screened technologies as components were presented to the USEPA, the DEQ, the Tribes, and the Trustees in a technical briefing on October 29, 2004. This EE/CA report summarizes the screening results. The Removal Action alternatives are then evaluated both individually and comparatively for their effectiveness, implementability, cost, and ability to achieve the stated Removal Action Objectives (RAOs) for the Terminal 4 Early Action. Following that analysis, a Preferred Alternative is identified.

Removal Action Area Characteristics

The Removal Action Area characteristics, which are relevant to the selection of technologies and alternatives appropriate to Terminal 4, and the methodologies by which the characteristics were determined are described in detail in the characterization report for the Terminal 4 Early Action (BBL, 2004b). Section 2 of this document provides brief summaries of the Removal Action Area characteristics. Appendices A and C through G of this

EE/CA report provide expanded summaries of Removal Action Area characteristics; an executive summary of Removal Action Area characteristics can be accessed in the characterization report (BBL, 2004b) as well.

Conceptual Model

A number of physical and chemical processes influence surface sediment contaminant concentrations within the Removal Action Area. Historical and potential ongoing sources – such as stormwater runoff, groundwater discharges, direct runoff and bank erosion, Removal Action Area sediment, operations, material handling, spills, and upstream contaminant sources to the Willamette River outside the Removal Action Area – may contribute contaminants to Terminal 4 sediment and surface water. Contaminant fate and transport within the surface sediment layer is controlled by several physical, biological, and chemical processes that together influence current and future surface sediment contaminant concentrations.

Section 3 presents the conceptual model of the Removal Action Area and summarizes the exposures and risks that may result from direct or indirect contact with sediment contaminants. The conceptual model of the Removal Action Area includes exposure pathways for human and ecological receptors to sediment contaminants, and the physical and chemical processes that control sediment contaminant concentrations. Section 3 also identifies specific chemicals of potential concern (COPCs) for specific receptor groups, such as benthic macroinvertebrates, birds, fish, wildlife, and humans. The purpose of the CSM is to identify the specific exposure pathways and receptors that are related to sediment contamination in the removal action area. This information was used to develop the Removal Action alternatives and will facilitate analysis of the residual (i.e., post-Removal Action) risks to ecological and human receptors following implementation of the Removal Action.

Removal Action Objectives

Section 4 reviews the RAOs initially established in the EE/CA work plan (BBL, 2004a), which are to:

- Reduce ecological and human health risks associated with sediment contamination within the Removal Action Area to acceptable levels.

- Reduce the likelihood of recontamination of sediments within the Removal Action Area.

The ability to achieve RAOs is one component of the evaluation of Removal Action alternatives. It is important to note that the Removal Action focuses on sediments within the Removal Action Area. The Removal Action will ultimately be part of the overall Remedial Action associated with the Portland Harbor Superfund Site. As such, the Removal Action is not intended to address all exposure pathways and environmental media within Terminal 4. The need for environmental cleanup for media other than sediments is being addressed by other programs, most notably the harborwide RI/FS under an Administrative Order on Consent with USEPA and the Upland Source Control program under Voluntary Cleanup Program agreements with DEQ. Achieving the RAOs for all receptors and pathways will be through a combination of actions resulting from all of the environmental programs.

Technology Screening

Section 5 summarizes the process through which technologies were screened to determine their appropriateness for inclusion in the development of Removal Action alternatives.

The Terminal 4 EE/CA work plan (BBL, 2004a) identified general technologies that would be considered for inclusion in the development of Removal Action alternatives. In accordance with USEPA guidance (USEPA, 1993) for NTCRAs, "only the most qualified technologies that apply to the media or source of contamination" should be considered. On that basis, the EE/CA work plan identified the following technologies for consideration in the development of Removal Action alternatives:

- monitored natural recovery (MNR), which may be applicable to portions of the Removal Action Area with low contaminant concentrations;

- in-situ capping of contaminated sediment; and

- sediment dredging (both mechanical and hydraulic) followed by auxiliary technologies such as transport, treatment, and/or onsite disposal of dredged sediments in a confined disposal facility (CDF) or offsite disposal of dredged sediments.

The Port screened these potentially applicable technologies to identify the technologies that are feasible and implementable at Terminal 4 and then assembled the Removal Action alternatives to include the screened technologies as components. Other factors considered in the development of the alternatives were the physical, chemical, and operational characteristics of the Removal Action Area and community feedback. In accordance with the AOC, the feasible and implementable technologies and a suite of Removal Action alternatives were presented to the USEPA, the DEQ, the Tribes, and the Trustees in a technical briefing on October 29, 2004.

Most of the technologies considered were found to be feasible, available, and applicable to the characteristics of Terminal 4, as summarized below.

- The screening analysis of MNR (which is discussed in Appendix B and detailed in Appendix H) resulted in a finding that MNR is a viable technology for a portion of Berth 401, a portion of Slip 1, a portion of Wheeler Bay, and the North of Berth 414 subarea. MNR has therefore been incorporated into the Removal Action alternatives.

- The screening analysis of capping technologies (which is discussed in Appendix B and detailed in Appendix I) resulted in a finding that capping in general is a technically feasible technology. Capping has therefore been incorporated into the Removal Action alternatives. The types of caps that might be needed to control erosion on steep slopes, such as concrete mattresses, were retained for further consideration during the design phase. Sand or gravel caps were retained for further consideration in parts of the Removal Action Area where the slopes are less steep and areas are less exposed to hydraulic forces and erosional impacts.

- The screening analysis of dredging technologies (which is discussed in Appendix B and detailed in Appendix J) resulted in a finding that dredging in general is a technically feasible technology. Dredging has therefore been incorporated into the Removal Action alternatives. Dredge types with wide availability and applicability to the Removal Action Area are mechanical dredge with open clamshell bucket, mechanical dredge with enclosed clamshell bucket, and hydraulic cutterhead dredge and hydraulic dredge, which was retained for possible use in conjunction with onsite disposal in a CDF.

- The screening analysis of transport technologies for dredged sediment (Appendix B) resulted in a finding that all the technologies considered (rail, barge, and truck and, for onsite disposal in a CDF, pipeline) are feasible, and none of the technologies was eliminated from consideration for the Terminal 4 Removal Action.

- The screening analysis of treatment technologies for dredged sediment (Appendix B) resulted in a finding that none of the treatment technologies considered (thermal treatment, extraction, chemical treatment, biological treatment/bioremediation, and immobilization) is appropriate for inclusion in the Removal Action alternatives. Treatment technologies for dredged sediment are either not feasible, not commercially available, or not applicable to the types of contaminants that are prevalent at Terminal 4. In addition, none of the surveyed vendors offering a process with potential applicability to the Removal Action Area sediments was interested in pursuing a project of this limited size and duration.

- The screening analysis of disposal technologies for dredged sediment (Appendix B) resulted in a finding that onsite disposal in a CDF and offsite disposal at a USEPA-approved landfill are both technically feasible technologies. Both disposal technologies have therefore been incorporated into the Removal Action alternatives. Appendix K details the evaluation of CDF feasibility.

- In addition, certain materials handling processes, such as dewatering and stabilization, were retained as technologies that may be considered to facilitate transportation and disposal of dredged sediment.

Applicable or Relevant and Appropriate Requirements

Section 6 identifies the legally applicable or relevant and appropriate requirements (ARARs) that may govern the Terminal 4 Removal Action. The ARARs fall into three classifications:

- Location-specific requirements are restrictions on activities based on the characteristics of a site or its immediate environment.

- Chemical-specific requirements are health- or risk-based concentration limits or ranges for specific hazardous substances, pollutants, or contaminants in various environmental media.

- Action-specific requirements are controls or restrictions on particular types of activities such as hazardous waste management or wastewater treatment.

In addition, the USEPA has developed another category called "to be considered" (TBCs), which includes non-promulgated criteria, guidance, and proposed standards issued by federal or state governments. While compliance with TBCs are not mandatory, TBCs may provide guidance on how to carry out certain actions or requirements

The ability of the Removal Action alternatives and the Preferred Alternative to achieve compliance with ARARs is a threshold criterion that must be met for this action.

Identification of Removal Action Alternatives

Section 7 summarizes the process by which Removal Action alternatives were developed and describes the alternatives. Following an analysis of the chemical, physical, and operational characteristics of the Removal Action Area's five subareas (Slip 1, Berth 401, Slip 3, Wheeler Bay, and the North of Berth 414 area), applicable technologies – monitored natural recovery, sediment capping, and/or sediment dredging with onsite or offsite disposal – are determined for each subarea. Five Removal Action alternatives addressing all five subareas are then assembled:

- No Action Alternative (required by statute as baseline against which to evaluate the other alternatives);
- Alternative A – MNR Emphasis;
- Alternative B – Cap Emphasis;
- Alternative C – Dredge Emphasis with CDF Disposal; and
- Alternative D – Dredge Emphasis with Landfill Disposal.

Alternatives A, B, C, and D all have MNR, capping, and dredging as components of the Removal Action, but vary in the degree to which they apply the technologies deemed feasible for Terminal 4. For instance, the estimated volume of dredged sediment ranges from 105,000 cubic yards (cy) under Alternatives A and B, which emphasize monitored natural recovery and capping, to 204,000 cy under Alternative D, which emphasizes dredging as a principal component. Only Alternative C includes onsite disposal of the dredged material in a CDF. Detailed descriptions of Alternatives A through D and how they would be applied in the five subareas are provided in Section 7.

Evaluation of Removal Action Alternatives

Section 8 evaluates the Removal Action alternatives, both individually and comparatively, for:

- effectiveness, as evidenced through the evaluation criteria of overall protection of public health and the environment; compliance with ARARs; long-term effectiveness; reduction of mobility, volume, and toxicity of wastes; and short-term effectiveness;
- implementability, as evidenced through the evaluation criteria of technical and administrative feasibility and availability; and
- cost.

Alternatives A, B, C, and D are all found to be effective and implementable. The estimated costs (total net present value) of the alternatives are $23,303,000 for Alternative A, $24,627,000 for Alternative B, $30,555,000 for Alternative C, and $26,431,000 for Alternative D. The CDF in Alternative C offers excess capacity that could be used for the disposal of contaminated sediments from other sites within the Portland Harbor Superfund

Site, as well as for the placement of other suitable sediments or fill; the estimated value of this excess capacity is placed at $10,000,000. Incorporating the estimated value of the excess capacity of the CDF, the net estimated cost of Alternative C is approximately $20,555,000.

On the basis of a comparative evaluation of the Removal Action alternatives against the CERCLA criteria, the alternatives are ranked by their scores on a scale of -1 to 1, in which -1 indicates an alternative is less favorable than the compared alternative; 0 indicates the two compared alternatives are equal; and 1 indicates an alternative is favored over the compared alternative. The four active alternatives are ranked in the following order:

- Alternative C (overall average score of 0.1333) is ranked the highest, reflecting its greatest overall relative performance at meeting the requirements of the evaluation criteria.
- Alternative B ranks second (overall average score of -0.1111).
- Alternative A ranks third (overall average score of -0.1222).
- Alternative D is considered to exhibit the least overall relative performance at meeting the requirements of the evaluation criteria and as a result ranks lowest of the four active alternatives (overall average score of -0.3).

The No Action alternative is not ranked, because it fails to meet the threshold criteria.

Preferred Alternative

Section 9 draws on the comparative analysis and ranking of alternatives and on USEPA guidance for conducting NTCRAs to identify the Preferred Alternative and provide the rationale for its selection. Alternative C is the Preferred Alternative because it best meets the evaluation criteria. Alternative C will meet the substantive requirements of the ARARs and offers greater overall protection of human health and the environment than do the other alternatives, because:

- The most contaminated sediment will be contained in a CDF designed and constructed to be protective of human health and the environment.
- Handling and transport of the contaminated sediments are minimized and kept within the Terminal 4 facility.
- The construction activities associated with implementation of the Preferred Alternative are essentially confined to the Terminal 4 facility, with little impact to the local community.
- The short-term risk of recontamination during implementation is minimized because a relatively small volume of sediment is moved over the shortest distance and because the contaminated sediment will be isolated from the Willamette River by a berm.
- The long-term risk of recontamination is reduced because Slip 1 is eliminated.

The Preferred Alternative is expected to exhibit relatively high short-term effectiveness, since its main components of dredging and CDF construction represent relatively little risk to the community, to site workers, and to the environment, and the duration of these activities is relatively short.

In addition, Alternative C is most compliant with the NTCRA requirement "to avoid wasteful, repetitive, short-term actions that do not contribute to the efficient, cost-effective performance of a long-term remedial action" (USEPA, 1993). Alternative C has the potential to contribute to the efficient, cost-effective performance of a long-term remedial action for the entire Portland Harbor Superfund Site because it provides a CDF disposal option that is nearby, efficient, and cost-effective and that decreases sediment management and handling.

Land created by filling Slip 1 would be used for water-dependent purposes consistent with existing zoning and current Port marine use at the Terminal 4 facility.

Recontamination Potential

The Preferred Alternative must also achieve the RAO of reducing the likelihood of recontamination of sediments within the Removal Action Area. Section 10 (reserved for this draft) presents an analysis of the recontamination potential of the Preferred Alternative.

Removal Action Process

Upon the approval of this EE/CA, USEPA will issue an Action Memorandum to document the selection of the removal action alternative proposed for implementation. Following the Action Memorandum, the Port is required to prepare a number of additional deliverables specified in the AOC and SOW prior to removal action construction activities. For the Removal Action design and implementation, these include:

- Removal Action Design Documents including construction drawings and specifications at various completion levels such as conceptual level (representing a 30% completion), pre-final (representing a 60% level of completion) and final, i.e., 100% complete design documents; and a

- Removal Action Work Plan that will describe the construction activities and their schedule, and will also include procedures to protect the public, site workers and the environment during field activities, and construction quality assurance procedures to ensure that the Removal Action Objectives and performance standards will be met.

The removal action design will involve the preparation of design calculations and analyses to work out design details, the preparation of design drawings, specifications, setting performance standards and procedures to verify that RAOs have been met. This design development process will gradually increase the specificity of the project details, in terms of refining areas and volumes of sediment involved, selecting construction processes, technology and equipment, disposal facilities and material borrow sources, and other project particulars. This process will culminate in the final (100%) design documentation that will provide specific project execution requirements and a combination of prescriptive specifications (where deemed necessary) and performance requirements (where appropriate to allow flexibility to contractors). The 100% (final) design will be used to competitively procure contractors for the implementation of the removal action in the field.

Construction of the Removal Action may affect aquatic environments in the Removal Action Area depending on the Alternative that is selected by USEPA. In accordance with the Clean Water Act, the Port will design and implement appropriate mitigation to offset the impacts to aquatic habitat. The mitigation planning process will proceed in parallel with the removal action design, and a final mitigation plan will be submitted with the final project design.

Upon the completion of the removal action field activities, the Port will prepare the Removal Action Completion Report and will also submit a Long-Term Monitoring and Reporting Plan and will commence long term monitoring activities.

Throughout the process, the Port has maintained an extensive community outreach effort, coordinated with EPA's community involvement programs and also coordinated with DEQ. This effort will continue through final construction of the Removal Action.

1. Introduction and Purpose

In 2000, the U.S. Environmental Protection Agency (USEPA) added the Portland Harbor Superfund Site (Superfund Site or Site) to the National Priorities List (NPL) pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 U.S.C. § 9601, et seq. (CERCLA or Superfund) (USEPA, 2001a). As shown on Figure 1-1, the Superfund Site Initial Study Area encompasses about 6 miles of the Willamette River in Portland, Oregon and includes the Terminal 4 facility. The Port of Portland (Port) owns Terminal 4 and leases land there to several marine tenants. Figure 1-2 shows a 2002 aerial view of Terminal 4.

In fall 2001, the USEPA and ten of the Superfund Site's potentially responsible parties entered into an Administrative Order on Consent for a Remedial Investigation/Feasibility Study (RI/FS), CERCLA-10-2001-0240 (USEPA, 2001a). The RI/FS will characterize the nature and extent of contamination and assess the biological and human health risks at the Superfund Site. The Administrative Order on Consent allows Early Actions to be conducted to address known contamination at specific locations within the Superfund Site. Contaminants found in Terminal 4 sediment samples during an RI directed by the Oregon Department of Environmental Quality (DEQ) led to a determination that a Removal Action at Terminal 4 is warranted. Accordingly, the Port is conducting a Non-Time-Critical Removal Action (NTCRA) under an Administrative Order on Consent for Removal Action (the AOC), CERCLA 10-2004-0009, executed by the Port and USEPA in October 2003. The Terminal 4 Removal Action Area, which is defined in the AOC, is shown on Figure 1-3.

The AOC sets forth the general legal requirements that govern the execution of the Early Action. Appendix A to the AOC is the statement of work (SOW) for the implementation of the Removal Action. This document provides a list of deliverables, their submittal schedule, and the technical requirements each deliverable has to meet in order to implement the Early Action.

The AOC requires the Port to conduct an engineering evaluation and cost analysis (EE/CA) of various alternatives for the Terminal 4 Removal Action to identify, compare, and rank Removal Action alternatives, assessing their relative performance at meeting specific objectives associated with the evaluation criteria of effectiveness, implementability, and cost.

To facilitate the EE/CA process, existing data from the Terminal 4 Removal Action Area were first evaluated to determine whether they provide information necessary and sufficient to allow comparison of Removal Action alternatives, selection of a Preferred Alternative, preparation of a design, and implementation of the selected alternative. This evaluation of the existing data identified a number of data gaps associated with the characteristics of the Removal Action Area and with the impact of those characteristics on the identification and evaluation of Removal Action alternatives. For each data gap, data quality objectives (DQOs) were developed in accordance with USEPA guidance (USEPA, 2000) describing the type of data needed, use of the data, methods for obtaining the data, and other requirements such as accuracy, repeatability, and quality control. These DQOs were presented in the EE/CA work plan (BBL, 2004a).

A field characterization effort was designed to meet a subset of the DQOs, namely those specific to physical, engineering, hydrogeologic, sediment quality, dredged sediment quality, and hydraulics and sedimentation characteristics of the Removal Action Area. The EE/CA work plan, which included a field sampling plan and quality assurance project plan, specified the sampling and analysis tasks that would be carried out to fill these data gaps and address the associated DQOs. This field effort was performed during May through September 2004. Following completion of the field and laboratory activities associated with the field characterization effort, a characterization report (BBL, 2004b) was prepared and submitted to USEPA; the characterization report summarizes the field exploration, sampling, testing, and laboratory activities carried out under the work plan and associated documents to meet the DQOs.

Based on the available characterization data, augmented with the newly collected data presented in the characterization report (BBL, 2004b), the Port screened potentially applicable technologies that would be considered for inclusion in the development of Removal Action alternatives. In accordance with the AOC, the feasible and implementable technologies and a suite of Removal Action alternatives that incorporate the screened technologies as components were presented to the USEPA, the DEQ, the Tribes, and the Trustees in a technical briefing on October 29, 2004. The assembled Removal Action alternatives are evaluated individually and in comparison to one another in this EE/CA report, and a Preferred Alternative is identified.

This EE/CA report was prepared in accordance with the requirements of the *Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA* (USEPA, 1993) and is organized in the following manner:

- Section 2 provides a summary description of the Removal Action Area characteristics, including historical and current uses and engineering, hydrogeologic, sediment chemistry, dredged sediment chemistry, and hydraulics and sedimentation characteristics.
- Section 3 presents the conceptual model of the Removal Action Area.
- Section 4 presents the Removal Action Objectives (RAOs).
- Section 5 summarizes the process through which feasible and implementable technologies were screened by the Port and assembled into Removal Action alternatives.
- Section 6 presents the potential location-, chemical-, and action-specific applicable or relevant and appropriate requirements (ARARs).
- Section 7 describes the four Removal Action alternatives, including the technology components of each and the subareas to be addressed using each technology.
- Section 8 presents individual and comparative evaluations of the Removal Action alternatives against the criteria set forth in the NTCRA guidance (USEPA, 1993).
- Section 9 presents the Preferred Alternative and the rationale for its selection.
- Section 10 (reserved in this draft) will present the recontamination analysis of the Preferred Alternative.
- Section 11 presents the references cited in this report.
- Appendices A through Q present supporting data and information.

As discussed, the primary objective of the EE/CA is to evaluate and compare removal action alternatives based on the current understanding of the site conditions and select one alternative as the Preferred Alternative for implementation.

Upon the approval of this EE/CA, USEPA will issue an Action Memorandum to document the selection of the removal action alternative proposed for implementation. Following the Action Memorandum, the Port is required to prepare a number of additional deliverables in accordance with the AOC and SOW prior to removal action construction activities. These include:

- Removal Action Design Documents including construction drawings and specifications at various completion levels such as conceptual level (representing a 30% completion), pre-final (representing a 60% level of completion) and final, i.e., 100% complete design documents; and a

- Removal Action Work Plan that will describe the construction activities and their schedule, and will also include procedures to protect the public, site workers and the environment during field activities, and construction quality assurance procedures to ensure that the Removal Action Objectives and performance standards will be met.

The removal action design will involve the preparation of design calculations and analyses to work out design details, the preparation of design drawings, specifications, setting performance standards and procedures to verify that RAOs have been met. This design development process will gradually increase the specificity of the project details, in terms of refining areas and volumes of sediment involved, selecting construction processes, technology and equipment, disposal facilities and material borrow sources, and other project particulars. This process will culminate in the final (100%) design documentation that will provide specific project execution requirements and a combination of prescriptive specifications (where deemed necessary) and performance requirements (where appropriate to allow flexibility to contractors). The 100% (final) design will be used to competitively procure contractors for the implementation of the removal action in the field.

Construction of the Removal Action may affect aquatic environments in the Removal Action Area depending on the Alternative selected by USEPA. In accordance with the Clean Water Act, the Port will design and implement appropriate mitigation to offset the impacts to the aquatic habitat. The mitigation planning process will proceed in parallel with the removal action design, and a final mitigation plan will be submitted with the final project design.

Upon the completion of the removal action field activities, the Port will prepare the Removal Action Completion Report and will also submit a Long-Term Monitoring and Reporting Plan and will commence long term monitoring activities.

Throughout the process, the Port has maintained an extensive community outreach effort, coordinated with EPA's community involvement programs and also coordinated with DEQ. This effort will continue through final construction of the Removal Action.

0 2 4

Scale in Miles

N

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PORT OF PORTLAND
PORTLAND, OREGON

TERMINAL 4 EARLY ACTION
EE/CA REPORT

VICINITY MAP

BBL
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engineers & scientists

FIGURE
1-1

0 600 1200

Approximate Scale in Feet

Note: Date of Photo: July 9, 2002

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TERMINAL 4 EARLY ACTION
EE/CA REPORT

TERMINAL 4 AERIAL PHOTOGRAPH

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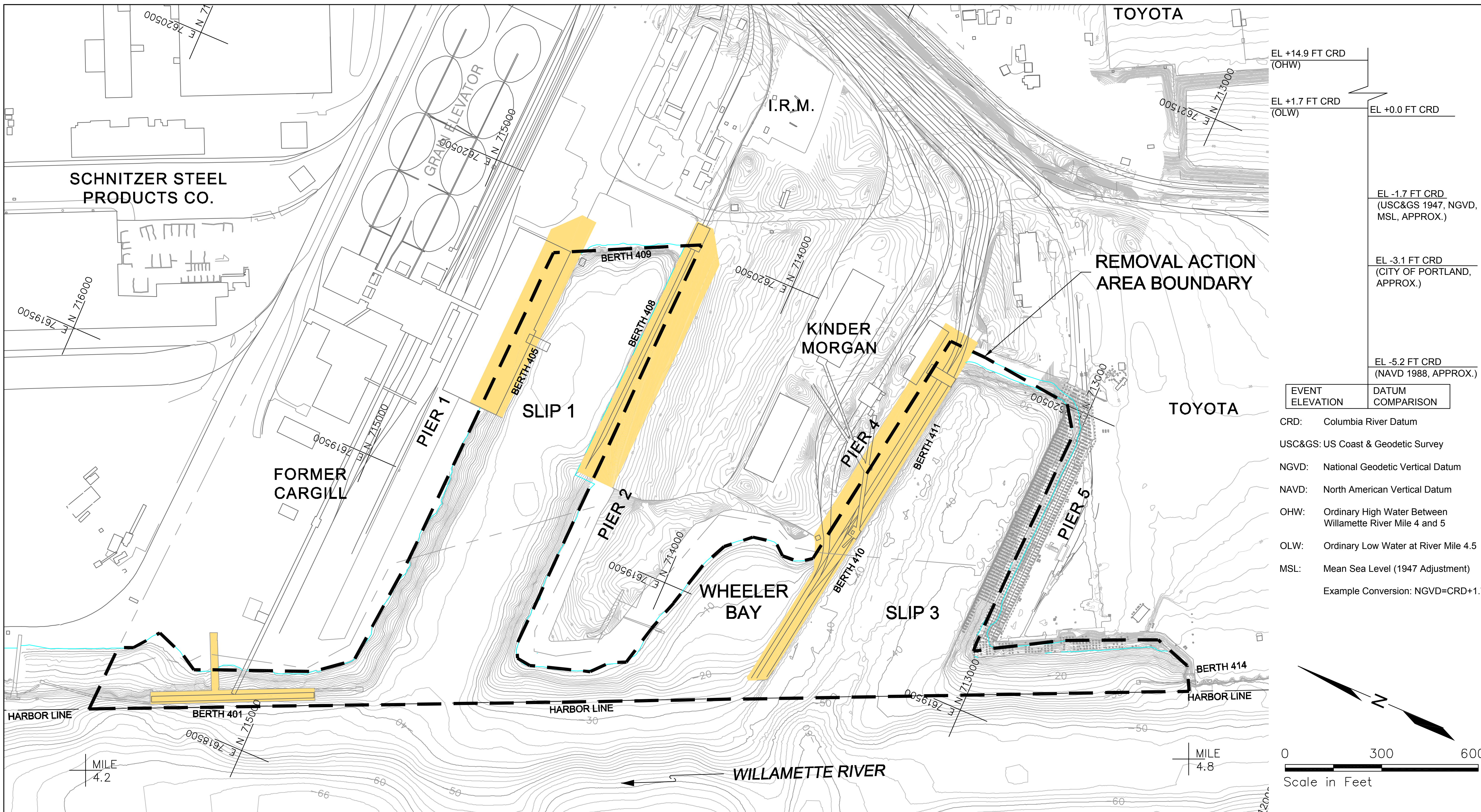
FIGURE
1-2



Notes:

1. Upland topographic vertical datum is NGVD; Bathymetric vertical datum is CRD.
2. Site Plan is based on drawings provided by the Port of Portland.
3. Shoreline boundary for Ordinary High Water is approximate.
4. Willamette River Mile reference marks are approximate.
5. Diurnal tide range during low river stages is 2.2 feet at St. Johns and 2.4 feet at Portland.
6. Datum conversion tables to CRD provided by Port of Portland.
7. Ordinary Low Water elevation provided by USACE.
8. Ordinary High Water elevation provided by Port of Portland.

Existing Piers

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TERMINAL 4 EARLY ACTION
EE/CA REPORT

REMOVAL ACTION AREA PLAN

BBL
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

FIGURE 1-3

DWG NAME: G:\project\Clients\BBL\Terminal 4\t4_036 (EECA 1-3).dwg
DATE: 12/01/04 09:37am

2. Removal Action Area Characteristics

Removal Action Area characteristics and the methodologies by which they were determined are described in detail in the characterization report for the Terminal 4 Early Action (BBL, 2004b). The brief summary provided in this section, which does not present new information, derives from that report and from the associated work plan for the Terminal 4 Early Action (BBL, 2004a). Appendices A and C through G of this EE/CA report provide expanded summaries of the two documents and include new and revised findings where applicable.

2.1 Area Boundaries

The Removal Action Area is within the Port of Portland's Terminal 4 facility at 11040 North Lombard Street in Portland, Oregon. The Terminal 4 facility itself is within or adjacent to the Portland Harbor Superfund Site. The Portland Harbor Superfund Site and the Removal Action Area are defined in the AOC as follows:

> Portland Harbor Superfund Site or "Superfund Site" or "Site" shall mean the Portland Harbor Superfund Site, in Portland, Multnomah County, Oregon, listed on the National Priorities List (NPL) on December 1, 2000, 65 Fed. Reg. 75179-01. The Site consists of the areal extent of contamination, including all suitable areas in proximity to the contamination necessary for implementation of response action, at, from and to the Portland Harbor Superfund Site Assessment Area from approximately River Mile 3.5 to River Mile 9.2 (Assessment Area), including uplands portions of the Site that contain sources of contamination to the sediments at, on or within the Willamette River. The boundaries of the Site will be initially determined upon issuance of a Record of Decision for the Portland Harbor Superfund Site.
>
> Removal Action Area or "Terminal 4 Removal Action Area"...shall mean that portion of the Site adjacent to and within the Port of Portland's Terminal 4 at 11040 North Lombard, Portland, Multnomah County, Oregon: extending west from the ordinary high water line on the northeast bank of the lower Willamette River to the edge of the navigation channel, and extending south from the downstream end of Berth 414 to the downstream end of Berth 401, including Slip 1, Slip 3, and Wheeler Bay.

2.2 Summary of Removal Action Area Characteristics

2.2.1 History of Terminal 4

Terminal 4 lies within the traditional homeland of the Chinookan peoples, who made use of the resources provided by the Columbia, Willamette, and Lower Willamette Rivers. In 1806, William Clark of the Lewis and Clark Expedition described and mapped the location of a small Chinookan village on the east bank of the Willamette River in the vicinity of what is now Terminal 4.

Few non-Native uses of the location prior to 1917 have been documented. The first developments in the Terminal 4 area occurred between 1906 and 1908, when Union Pacific constructed the railroad along the eastern edge of the floodplain, and a pipeline and oil dock along the south side of the modern Slip 3. In 1917, site preparation for the development of Terminal 4 began. Construction of Terminal 4 led to substantial changes in the landscape between 1917 and 1921. Trees and other vegetation were removed over most of the floodplain in the Terminal 4 area, and dredged fill material was deposited across low-lying ground, in most of lower Gatton's Slough, and into offshore shallows to extend the riverbank. Construction of Slips 1, 2, and 3 quickly followed.

Past tenant operations at Terminal 4 involved the movement by rail, vessel, and barge of bulk commodities such as grains and mineral concentrates. Operations at Terminal 4 have also included the storage and use of petroleum products such as diesel fuel, bunker C oil, and gasoline, which were typically contained in underground storage tanks (USTs) and aboveground storage tanks (ASTs) at the St. Johns Tank Farm and at various discrete business locations. Many of those tanks have since been removed. Pipelines to move bulk liquids and to fuel locomotives and other equipment were in use, and a fumigation facility was also operated at Terminal 4. In addition, pencil pitch, a coal tar distillate, was handled at Terminal 4 from 1978 to 1998.

The history of the Terminal 4 area and historical tenant operations is described in detail in the work plan (BBL, 2004a) and is presented in Appendix A, including new and revised findings where applicable. Appendix A provides a chronology of facility development between 1906 and 1999, a chronology of dredging and filling activity between 1917 and 2003, and a detailed description of Terminal 4 operations beginning in 1917.

2.2.2 Current Uses of Terminal 4

Current tenants at the Terminal 4 upland adjacent to the Removal Action Area are Cereal Food Processors, International Raw Materials, Rogers Terminal, Kinder Morgan Bulk Terminals (KMBT), and Schnitzer Steel Products, which has a moorage agreement. Adjacent property owners include Schnitzer Steel Industries, Northwest Pipe and Casing, and Burgard Industrial Park (housing both Boydstun Metal Works and Western Machine Works), all of which are under Voluntary Cleanup Program Agreements with the DEQ for remedial investigation of those properties. 528 Investors LLC (pallet company) is located in the southern portion of Terminal 4 (formerly Toyota Motor Sales), but is not adjacent to the Removal Action Area. The work plan (BBL, 2004a) provides more detail on current uses of Terminal 4, which are summarized in Appendix A.

2.2.3 Engineering Characteristics

Engineering characteristics of the Removal Action Area are described in detail in the characterization report (BBL, 2004b). That material is summarized in Appendix C. The engineering characteristics of the Removal Action Area were initially summarized in BBL, 2004b as follows:

- A soil unit described as brown, loose to medium dense sand was encountered in the upland borings across Terminal 4. Saturated portions of the sand are likely prone to liquefaction during strong seismic shaking.

- A soil unit described as very soft, organic silt and clay was generally encountered in the top portion of in-water explorations. The results of consolidation tests indicate that these soils are highly compressible and would likely settle significantly under structural loads or the weight of fill. It is expected that these soils are normally consolidated and have very low undrained shear strengths.

- A soil unit described as very soft to medium stiff organic and inorganic silts and clays was encountered in upland explorations mainly to the east of the historical shoreline and east of Slips 1 and 3. Because this soil was encountered east of Slips 1 and 3, its geotechnical engineering characteristics would affect only upland structures underlain by this material, which exhibits relatively high compressibility. Heavy upland structures and fill placed on these deposits could potentially be subject to excessive time-dependent consolidation settlements.

- A soil unit described as interbedded silt and sand (medium stiff to stiff/medium dense) was encountered east of Gatton's Slough. This material may be normally consolidated to slightly overconsolidated at depths below 60 feet. Portions of these soils likely exhibit moderate compressibility, and undrained shear strength of the cohesive soils likely varies with depth based on the state of consolidation.

- A soil unit described as dark grey, loose to medium dense sand underlies large portions of the Terminal 4 area west of Gatton's Slough and was generally encountered below the fill in upland explorations and below the surficial sediments in in-water explorations. The combination of fairly low density and small fines content of this material makes the saturated portions of the sand potentially prone to liquefaction during strong seismic shaking.

- Gravel and gravel and sand were encountered in the deep monitoring wells below the dark grey native sands. Because of its depth, this soil unit is not likely to impact structures or construction activities at the surface, although it will affect hydrogeologic aspects of the project.

2.2.4 Hydrogeologic Characteristics

Hydrogeologic characteristics of the Removal Action Area are described in detail in the characterization report (BBL, 2004b). That material is summarized in greater depth and updated on the basis of newly acquired information in Appendix D. The hydrogeologic characteristics of the Removal Action Area were initially summarized in BBL, 2004b as follows:

- Groundwater elevations varied across Terminal 4 and were higher in the upland portions than at near-river locations. Horizontal hydraulic gradients were toward the river for groundwater in the upland fill, Unconsolidated Alluvial Deposits, and Troutdale Gravel, the three geologic units of interest. In the eastern portion of Terminal 4 (east of the former shoreline), these three units form distinct hydrostratigraphic units. In the western portion of Terminal 4 (west of the former shoreline), the upland fill and Unconsolidated Alluvial Deposits form a single hydrostratigraphic unit. Because groundwater elevations were greater than river stage, groundwater was discharging to the Willamette River during the monitoring period. Estimated horizontal groundwater flow velocities may vary over five orders of magnitude in the various soil types encountered.

- The data indicate that vertical groundwater flow at Terminal 4 is dynamic and may be influenced by different factors, such as river stage or resistance to flow by fine-grained materials, at different locations. Vertical hydraulic gradients were primarily upward at some locations (e.g., intermediate to shallow groundwater at monitoring well cluster T4-MW02) and primarily downward at others (e.g., shallow to intermediate groundwater at T4-MW05 and intermediate to deep groundwater at T4-MW02), while vertical hydraulic gradient reversals were observed between shallow and intermediate groundwater and between intermediate and deep groundwater at T4-MW01 and T4-MW06.

- Tidally and precipitation-induced changes in the Willamette River stage caused changes in groundwater elevation that were similar in magnitude and direction for groundwater in the Unconsolidated Alluvial Deposits and Troutdale Gravel at monitoring well cluster T4-MW06.

- River stage-induced groundwater elevation changes were also observed for shallow, intermediate, and deep groundwater at T4-MW01, for shallow and intermediate groundwater at T4-MW04, for shallow groundwater at T4-MW06, and for deep groundwater at T4-MW02 and T4-MW03. The observed tidal effects in deep groundwater at the upland well locations (T4-MW02 and T4-MW03) likely indicate that the Troutdale Aquifer is under semi-confining conditions.

- Groundwater elevations and vertical and horizontal hydraulic gradients will likely vary at different river stages, particularly for groundwater in the upland fill during periods of higher river stage. During the monitoring period, the Willamette River stage was relatively low; additional groundwater data should be collected during a higher river stage to evaluate the effect of higher river stage on groundwater elevation and vertical and horizontal hydraulic gradients at Terminal 4.

Monitoring well locations discussed above are shown on Figure D-1 in Appendix D of this document.

2.2.5 Sediment Quality Characteristics

Sediment quality characteristics of the Removal Action Area are described in detail in the characterization report (BBL, 2004b). That material is summarized in Appendix E. The sediment quality characteristics of the Removal Action Area were initially summarized in BBL, 2004b as follows:

Chemical concentrations in sediments were evaluated against two sediment quality guidelines for screening purposes only: threshold effects concentrations (TECs) and probable effects concentrations (PECs). The use of these guidelines does not imply that they should or would be used as cleanup levels for the Removal Action Area. The USEPA and the Lower Willamette Group will be developing cleanup levels for the Portland Harbor Superfund Site in the future.

The TEC is a low effects guideline that represents concentrations below which toxicity effects are unlikely to be observed in freshwater benthic invertebrates. The PEC is a probable effects guideline that represents concentrations above which toxicity effects are likely to be observed in freshwater benthic invertebrates.

Exceedance ratios were calculated by dividing the chemical concentration by the TEC and PEC. A TEC exceedance ratio of greater than 1 indicates a concentration greater than the TEC. A PEC exceedance ratio of greater than 1 indicates a concentration greater than the PEC.

TEC exceedances are numerous and widespread. PEC exceedances, which represent the highest chemical concentrations, are summarized below:

Surface Sediment

- some polycyclic aromatic hydrocarbons (PAHs) in some samples of Slip 1 surface sediment; the maximum PEC exceedance ratio for total PAHs was 2;
- total DDT in one Slip 1 surface sediment sample, with a PEC exceedance ratio of less than 2;
- total PCBs in one Slip 1 surface sediment sample, with a PEC exceedance ratio of less than 2;
- lead in one Wheeler Bay surface sediment sample, with a PEC exceedance ratio of less than 2;
- some PAHs in one sample of Wheeler Bay surface sediment; the PEC exceedance ratio for total PAHs in that sample was less than 2;
- lead in two samples and zinc in one sample of Slip 3 surface sediment; the lead PEC exceedance ratios were 2 and 5, and the zinc PEC exceedance ratio was less than 2; and
- some PAHs in some samples of Slip 3 surface sediment; the maximum PEC exceedance ratio for total PAHs was 26.

Under-Pier Sediment

- cadmium, lead, and zinc in one sample of Slip 1 under-pier sediment; the PEC exceedance ratios were 1, 15, and 2, respectively;
- some PAHs in two samples of Slip 1 under-pier sediment; PEC exceedance ratios were less than 2 for fluoranthene, pyrene, benzo(a)anthracene, and chrysene and 3 for anthracene;
- cadmium, lead, and/or zinc in some samples of Slip 3 under-pier sediment; the maximum PEC exceedance ratios were 2, 13, and 4, respectively, all in the same sample; and
- some PAHs in some samples of Slip 3 under-pier sediment; the maximum PEC exceedance ratio for total PAHs was 18.

Subsurface Sediment

- zinc in one sample of Berth 401 subsurface sediment (not extending below 3 feet below mudline), with a PEC exceedance ratio of less than 2;
- lead and zinc in one sample of Slip 1 subsurface sediment, with PEC exceedance ratios of 2 and 1, respectively;
- some PAHs in some samples of Slip 1 subsurface sediment; however, total PAH concentrations in those samples were below the PEC;
- total DDD in one sample of Slip 1 subsurface sediment, with a PEC exceedance ratio of 2;
- lead and mercury in one sample of Wheeler Bay subsurface sediment, with PEC exceedance ratios of 24 and 1, respectively;

- some PAHs in some samples of Wheeler Bay subsurface sediment; the maximum PEC exceedance ratio for total PAHs was 4;
- mercury in one sample and lead in five samples of Slip 3 subsurface sediment; all had PEC exceedance ratios of 2 or less;
- some PAHs in some samples of Slip 3 subsurface sediment; the maximum PEC exceedance ratio for total PAHs was 3;
- total DDD and total DDT in one sample of Slip 3 subsurface sediment, with PEC exceedance ratios of 2 and 1, respectively; and
- total PCBs in one sample of Slip 3 subsurface sediment, with a PEC exceedance ratio of less than 2.

The streamlined risk evaluation, presented in Appendix M, along with the TEC and PEC guidelines, was used to define the Removal Action.

2.2.6 Dredged Sediment Quality Characteristics

"Dredged sediment quality characteristics" refers to the characteristics of the sediments that would be dredged. Dredged sediment quality characteristics of the Removal Action Area are described in detail in the characterization report (BBL, 2004b). That material is summarized in greater depth and updated on the basis of newly acquired information, including results of the thin-column leaching test, in Appendix F. The characterization report did not develop conclusions on the basis of the dredging elutriate, column settling, and modified elutriate tests performed to determine dredged sediment quality characteristics. Instead, these elements are evaluated in this EE/CA report, where (1) the results for the dredging elutriate tests are compared to relevant surface water quality criteria to evaluate potential impacts to surface water during dredging, and (2) the results of the column settling and modified elutriate tests are evaluated to aid in determining design characteristics for a confined disposal facility (CDF). In addition, the characterization report indicated that:

- Two composite samples analyzed for characteristics that could impact offsite disposal decisions did not display hazardous waste characteristics, and toxicity characteristics leaching procedure (TCLP) concentrations for the samples were below the TCLP criteria. In addition, the two composite samples passed the paint filter test, indicating the material would likely be acceptable for transport from Terminal 4 and offsite landfill disposal.

2.2.7 Hydraulics and Sedimentation Characteristics

Hydraulics and sedimentation characteristics of the Removal Action Area are described in detail in the characterization report (BBL, 2004b). That material is summarized in greater depth in Appendix G. The hydraulics and sedimentation characteristics of the Removal Action Area were initially summarized in BBL, 2004b as follows:

- Hydraulics within Slips 1 and 3 are affected by variations in river flow, river stage, ship-induced currents, and, to a lesser extent, localized currents from stormwater discharges.

- In general, given the orientation of the slips relative to the river, river-induced currents in the slips are low in velocity compared to the river velocity.

- Although river-induced currents have an influence on hydraulics of the Removal Action Area, current velocities in a majority of the Removal Action Area are dominated by propeller-induced currents.

- Propeller-induced currents cause circulation and increased velocities and turbidity levels that extend beyond the paths that ships take in Slip 3.

- Propeller-induced currents influence hydrodynamics and sediment transport in the Removal Action Area.

- Ongoing river-induced sedimentation of suspended sediments occurs nearly continuously throughout the Removal Action Area. The periodic redistribution of this material affects long-term sediment accumulation patterns within the slips.

- The data gathered during the field program are representative of low-flow, low-rainfall conditions; additional data (currently being collected) are needed to support characterization of hydraulics and sedimentation in the slips under high-flow, high-rainfall conditions.

The information summarized above is described in more detail in Appendix G. The collection of additional data to support the evaluation of hydraulics and sedimentation characteristics within the Removal Action Area during high-flow, high-rainfall conditions is ongoing. An evaluation of this newly acquired information will be presented in the subsequent draft of the EE/CA report.

3. Conceptual Model of Removal Action Area

This section presents the conceptual model of the Removal Action Area and summarizes the exposures and risks that may result from direct or indirect contact with sediment contaminants. The conceptual model of the Removal Action Area includes exposure pathways for human and ecological receptors to sediment contaminants that may be applicable to the Removal Action Area and the physical and chemical processes that control sediment contaminant concentrations.

A number of physical and chemical processes influence surface sediment contaminant concentrations within the Removal Action Area. Historical and potential ongoing sources – such as groundwater discharges, direct runoff and bank erosion, operations, material handling, spills, stormwater runoff, and upstream contaminant sources to the Willamette River outside the Removal Action Area – may contribute contaminants to Terminal 4 sediment and surface water. Contaminant fate and transport within the surface sediment layer is controlled by several physical processes (e.g., sedimentation and resuspension), biological processes (e.g., biodegradation and biological stabilization), and chemical processes (e.g., oxidations/reduction). Together, these processes influence current and future surface sediment contaminant concentrations.

Exposure pathways describe the mechanisms by which a receptor becomes exposed to contaminants. At a minimum, a complete exposure pathway must include a source, a release mechanism, a transport mechanism, and a route of exposure for each receptor. If any component is missing, the exposure pathway is deemed incomplete. The following discussion identifies the potential exposure pathways and the receptors that may be exposed to sediment contaminants in the Removal Action Area. In this discussion, "sediment" refers to both the solid and liquid (i.e., porewater) components of bulk sediment.

3.1 Receptors, Exposure Pathways, and Chemicals of Potential Concern

Figure 3-1 illustrates the potential exposure pathways, as well as representative ecological and human receptor types. For humans and wildlife, exposure to metals via dermal contact with sediments is typically considered minor compared to the ingestion pathways. However, dermal exposure to organic compounds can contribute to risk if the frequency and duration of contact are high enough. For aquatic invertebrates and fish, external contact with sediment, including porewater, can be important for metals and organic compounds.

3.1.1 Receptors and Exposure Pathways

As noted above, both human and ecological receptors may be exposed to sediment contaminants through direct or indirect means. Direct exposure results from contact with contaminated sediment. Direct exposure pathways may include contact between receptors' external surfaces and contaminated bed sediment, including porewater; ingestion of contaminated sediment by receptors, either incidentally during drinking or eating or as part of the feeding process (e.g., filter feeders); and contact between the receptor and resuspended sediment (e.g., ventilation of gill surfaces).

For human receptors, direct exposure results from activities that involve contact with sediments. Such activities include workers involved with operations or maintenance at Terminal 4, or fishers that may contact sediments while retrieving traps or nets that have contacted contaminated sediment. Ecological receptors are subject to direct exposure if they live in or on contaminated sediments, or contact the sediments while feeding. This includes species such as benthic macroinvertebrates that live in sediments, benthic fish such as sculpin that spend most of their time on or near the sediment, and fish and wildlife species that may ingest sediments accidentally while feeding.

Indirect exposure results from contact with contaminants that have been transferred from sediments to another exposure medium. Indirect exposure pathways may include ingestion of food that has become contaminated through contact with sediment contaminants. In some cases, chemicals can bioaccumulate in biota resulting in exposure to upper trophic level ecological receptors or human that may ingest fish or other biota taken from the Removal Action Area. Bioaccumulation is especially important for aquatic-based food webs and generally occurs through one of two processes, bioconcentration and biomagnification. Bioconcentration is the increase in concentration of a chemical in an organism resulting from tissue absorption levels that exceed the rate of metabolism and excretion. Metals and organic compounds may bioconcentrate. Biomagnification occurs when concentrations of a chemical in biota increase with successive trophic levels. Biomagnification is best known with regard to persistent organic chemicals such as DDT and PCBs, but can also occur for organically transformed metals.

Humans that ingest fish or invertebrates taken from contaminated sediment areas may experience indirect exposure if contaminants have accumulated in tissues. A broad range of fishing activities is known to occur in the Lower Willamette River. In the Removal Action Area, recreational bass and crappie fishing in Slip 3 and Wheeler Bay is known to occur. The extent to which the Removal Action Area supports more subsistence-level fishing is not known. Predatory fish, birds, and mammals may also experience indirect exposure if they feed in the Removal Action Area.

3.1.2 Chemicals of Potential Concern

The chemicals detected in Removal Action Area sediments are described in Section 4. Chemicals of potential concern for risk at the site include metals, PAHs, pesticides, phthalates, and PCBs. These chemical groups were expected to be present at elevated concentration based on results of previous sampling in Terminal 4 (e.g., Hart Crowser 2000). In Appendix M, risks from lead, zinc, DDT (including DDD and DDE), and PCBs are discussed in more detail. These chemicals are not the only analytes of potential concern at the site, but they are probably among the most important in terms of risk-based decision making and are good indicators of contaminant distribution at the site.

3.2 Physical and Chemical Processes in the Removal Action Area

A number of physical and chemical processes govern contaminant fate and transport within the Removal Action Area. This section provides an overview of the conceptual model of potential sources of contaminants to

Removal Action Area sediment and the physical and chemical processes that affect contaminant fate and transport within the surface sediment.

3.2.1 Sources of Sediment Contamination

A conceptual model of potential sources of contaminants to Removal Action Area sediment is shown on Figure 3-2. Contaminants transported to the Removal Action Area may be dissolved or associated with particulate matter. Contaminants associated with particulate matter may contaminate surface sediment through localized or area-wide deposition, depending on grain size and transport mechanisms. Dissolved-phase contaminants may partition onto particulate matter suspended in the water column and subsequently deposit onto surface sediment within the Removal Action Area. Data collected during the 2004 EE/CA field program indicate that river-induced and propeller-induced currents within the Removal Action Area affect sediment (i.e., particulate) deposition and redistribution.

Potential historical and ongoing sources of sediment contamination are discussed in detail in Appendix A and are summarized below.

3.2.1.1 Upstream Sources

Potential upstream sources include resuspended sediment from potentially contaminated areas upstream, stormwater discharges from upstream outfalls, industrial point-source discharges, non-point-source discharges from industrial activities and overland flow, over-water activities, and other indirect sources. In river systems such as the Willamette, contaminant loading from upstream sources is typically dominated by the transport and deposition of particle-bound contaminants or suspended sediment in the area of concern.

3.2.1.2 Stormwater Outfalls

Contaminants associated with particulate matter discharged from stormwater outfalls may potentially impact portions of the Removal Action Area through localized deposition. Discharges from the outfalls may also affect broader areas through the discharge and dispersion of dissolved-phase contaminants or contaminants associated with fine particulate matter. Drawings provided by the Port indicate that 16 stormwater outfalls from 11 catchment basins discharge directly into the Removal Action Area. This includes one City of Portland stormwater outfall that collects runoff from areas outside of Terminal 4. The remaining outfalls collect runoff from Terminal 4. At least five additional outfalls, including one City of Portland stormwater outfall and one City of Portland combined sewer overflow outfall, discharge into the river immediately upstream of Berth 414 and the Removal Action Area.

The Port’s MS4 Permit requires a stormwater management program. The Port implements a Municipal Stormwater Management Plan that addresses applicable stormwater program requirements. The plan applies to all Port facilities within the City of Portland’s Urban Services Boundary, including Terminal 4. As required by the permit, the Port reports on the status of the plan through annual reports submitted to DEQ. In addition, the

Port uses redevelopment/improvement projects as an opportunity to evaluate and upgrade, as necessary, the stormwater management systems at Terminal 4. As a result, the magnitude of this potential source is expected to decline into the future.

3.2.1.3 Groundwater Discharges

Two potential pathways for the transport of contaminants associated with groundwater to the Removal Action Area are the seepage of nonaqueous-phase liquid (NAPL) from historical upland releases and the transport of dissolved-phase constituents present in groundwater discharges. The potential transport of dissolved-phase contaminants present in the groundwater to surface sediment can occur through two primary mechanisms: (1) the partitioning of contaminants present in the groundwater to the surface sediment; and (2) the transport of dissolved-phase contaminants from groundwater to surface water within the Removal Action Area, subsequent partitioning onto particulate matter suspended in the water column, and deposition onto the sediment surface.

The upland source control evaluations at Terminal 4 have indicated one area where light nonaqueous-phase liquid (LNAPL) is present in the subsurface. The LNAPL is located east of Slip 3 as a result of petroleum produce releases from historical Union Pacific Railroad storage and pipeline transportation activities. Petroleum hydrocarbon seeps were historically observed within Slip 3 due to releases from Union Pacific Railroad pipelines (Hart Crowser, 2004a). Small quantities of LNAPL (approximately 56 gallons) were recovered during LNAPL monitoring and recovery efforts conducted in this area (referred to as the Terminal 4 Slip 3 Upland Facility) from August 2003 through April 2004. Based on these results, the current conceptual hydrogeologic model for the area indicates that only a small volume of mobile LNAPL is present in the subsurface at the Terminal 4 Slip 3 Upland Facility. In response to the presence of LNAPL, the Port completed a bank excavation and backfill remedial action (BEBRA) in this area in 2004, which has mitigated the potential for LNAPL and dissolved-phase petroleum hydrocarbon seepage. Ongoing upland source characterization and control activities are currently being conducted by the Port under the Upland Source Control Program pursuant to Voluntary Cleanup Agreements with DEQ.

3.2.1.4 Direct Runoff and Bank Erosion

Direct surface-water runoff and bank erosion represent potential historical and ongoing sources of contamination to Removal Action Area sediment. Areas with significant overland surface-water runoff have not been observed during recent field programs at Terminal 4. As a result, direct surface-water runoff is not expected to represent a significant source of ongoing contamination. Bank erosion was observed in the area to the west of Berth 408 in Slip 1 and in Wheeler Bay and may present a potential source of ongoing localized contamination in these two areas. Sampling of these areas has been and is being conducted as part of the Terminal 4 Slip 1 Upland Source Control Program to evaluate the potential for the bank to contain COPCs and, therefore, be of concern as a potential ongoing source. Overall, bank erosion is not expected to represent a significant source of ongoing area-wide contamination to the Removal Action Area.

3.2.1.5 Removal Action Area Sediment

Data collected during the 2004 field program suggest that vessel activity has a significant influence on sediment resuspension and redistribution within portions of the Removal Action Area (e.g., Slip 3). The historical redistribution of sediment due to vessel activity is an important consideration in the evaluation of existing sediment chemistry data. The redistribution of sediment is also a potential concern during the implementation of any Removal Action that combines approaches (e.g., partial dredging and capping of other areas) or that occurs partially or in sequence (e.g., multiple-pass dredging).

Resuspension and redistribution of Removal Action Area sediment is not considered to be a potential source of ongoing post-Removal Action contamination. Although sediment resuspension due to vessel activity within portions of Terminal 4 appears to be significant, the potential for future contamination caused by the redistribution of contaminated sediment will be addressed through the Removal Action.

3.2.1.6 Atmospheric Deposition

Precipitation and dry deposition of regional atmospheric contaminants, as well as wind-blown particles from nearby, are potential sources of contaminants to the Removal Action Area. The deposition of regional atmospheric contaminants is not considered to be significant because of the relatively low air catchment associated with Terminal 4. However, the historical deposition of air-borne contaminants from local sources is potentially more significant. Local sources of air-borne contaminants are controlled under existing air permitting requirements and are therefore not considered to be a significant source of ongoing contamination to Removal Action Area sediment.

3.2.1.7 Existing and Future Structures

Treated timber structures may contribute some PAHs to the Removal Action Area, although likely not at significant levels. Structures in the Removal Action Area potentially constructed of creosote-treated timbers include the timber pilings for Piers 1 and 2 in Slip 1 (below pile caps and below visible pier timber framework); Berth 410 of the KMBT pier; and the Slip 3 timber pile field along former Pier 5.

3.2.1.8 Operations, Material Handling, and Spills

Historical Terminal 4 operations, material handling, and spills are potential sources of sediment contamination in the Removal Action Area. Historical Terminal 4 operations are described in Appendix A. Routine operations, material handling, and spills are not expected to present a significant source of ongoing contamination to Terminal 4. Under current operating practices, there is a low likelihood of a significant spill occurring at Terminal 4. In addition, no current or planned bulk handling of materials containing COPCs has been identified for the Removal Action Area. If a spill did occur, there is a high likelihood that it would be detected and subsequently addressed under an emergency response action.

3.2.2 Contaminant Fate and Transport within Surface Sediment

Potential physical, chemical, and biological processes that affect contaminant concentrations within Removal Action Area surface sediment include:

- physical processes: sedimentation, resuspension, dispersion, advection, diffusion, bioturbation, and volatilization;
- biological processes: biodegradation, biotransformation, phytoremediation, and biological stabilization; and
- chemical processes: oxidation/reduction, stabilization, and sorption.

These physical, chemical, and biological processes are discussed in greater detail in Appendix B. Generally, these processes affect contaminant concentrations in surface sediment in the following ways:

- Sedimentation causes contaminated or clean sediments to cover the existing surface, resulting in a change in COPC concentrations.

- Resuspension due to river-induced or propeller-induced currents results in the redistribution or dispersion of contaminants within the Removal Action Area, which could affect COPC concentrations.

- Diffusion of dissolved contaminants from the sediment into the overlying water column results in the transport of contaminants to other areas within the Removal Action Area or outside of Terminal 4, which could affect COPC concentrations.

- Bioturbation (caused by the movement of benthic organisms) results in mixing and potential changes to the redox potential of surface sediment.

- Biodegradation or chemical transformation results in the conversion of contaminants to potentially less toxic forms. These processes can also result in the conversion of contaminants to more toxic forms (e.g., mercury to methyl mercury and trichloroethene to vinyl chloride). The COPCs in the Removal Action Area are not compounds that typically convert to more toxic forms. Volatile organic compounds, including trichloroethene, are not COPCs for the Removal Action. Mercury has been detected in the Removal Action Area, but generally at concentrations below representative sediment quality guidelines. Biodegradation and chemical transformation at the Removal Action Area are believed to result in the conversion of contaminants to less toxic forms.

- Volatilization results in the transport of dissolved contaminants from the water column into the overlying air.

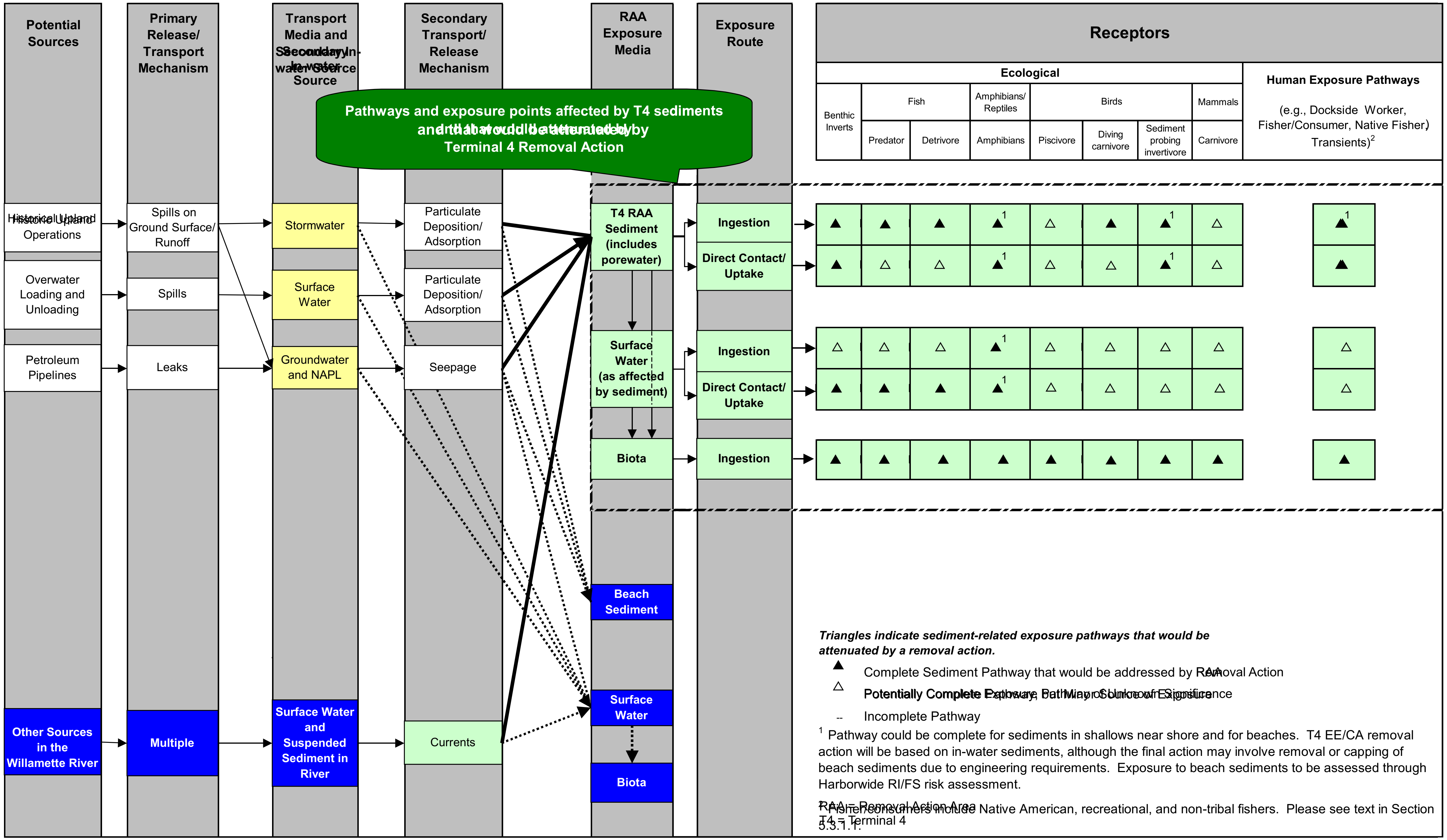
- Biological processes degrade, transform, or stabilize contaminants within the surface sediment, resulting in potentially reduced toxicity, mobility, and/or bioavailability.

- Oxidation/reduction reactions alter contaminant mobility and/or bioavailability. These processes are often linked to biological activity within the sediment.

- Sorption to sediment results in reduced contaminant mobility and/or bioavailability.

Potential ongoing sources and the fate and transport of surface sediment contaminants are assessed in the evaluation of monitored natural recovery in Appendix H and the recontamination analysis provided in Appendix N.

NOTE: This diagram is intended to show (1) the potential pathways by which generalized receptors may be exposed to contaminants through sediment-associated pathways, and (2) those pathways that would be attenuated, in whole or in part, by sediment removal actions at T4. Due to the streamlined nature of the EE/CA process, not all pathways will be the subject of extensive risk analysis in the EE/CA.



Color Coding to indicate Programmatic Relationships

Terminal 4 Removal Action	Terminal 4 Upland Source Control	Portland Harbor Superfund RI/FS

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This document is currently under review by US EPA and its federal, state and tribal partners, and is subject to change in whole or in part.

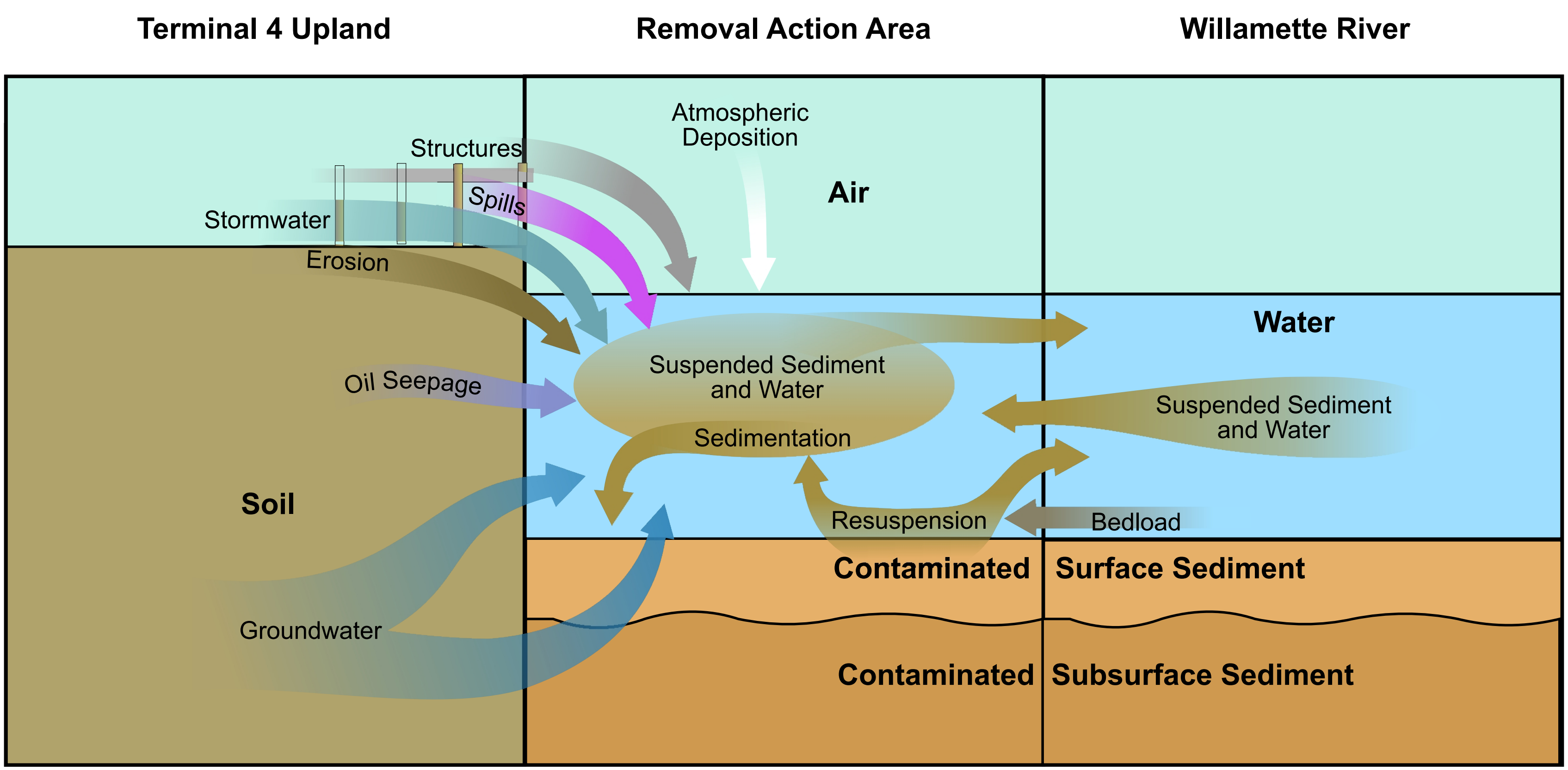
PORT OF PORTLAND
PORTLAND, OREGON

TERMINAL 4 EARLY ACTION
EE/CA REPORT

CONCEPTUAL MODEL FOR TRANSPORT AND EXPOSURE PATHWAYS RELEVANT TO THE TERMINAL 4 EE/CA

BLASLAND, BOUCK & LEE, INC.
engineers & scientists

FIGURE
3-1



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TERMINAL 4 EARLY ACTION
EE/CA REPORT

GEOCHEMICAL CONCEPTUAL MODEL

BBL®
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

FIGURE
3-2

4. Removal Action Objectives

Removal Action Objectives (RAOs) were broadly established in the work plan for the Terminal 4 Early Action (BBL, 2004a) and are repeated here. The purpose of establishing RAOs is to focus the analysis of Removal Action alternatives, so that the alternatives are evaluated not only for their relative effectiveness, implementability, and cost, but also for their ability to achieve RAOs.

4.1 Removal Action Objectives

The RAOs for the Terminal 4 Removal Action are to:

- Reduce ecological and human health risks associated with sediment contamination within the Removal Action Area to acceptable levels.

- Reduce the likelihood of recontamination of sediments within the Removal Action Area.

4.2 Discussion of Removal Action Objectives

The following discussion expands on the RAOs to further refine the objectives. For example, one RAO is to "reduce ecological and human health risks" to "acceptable levels." To aid in understanding and achieving that RAO, this section summarizes the risks, discusses how they can be reduced, and defines what constitutes an acceptable level of risk.

4.2.1 Human Health Risks Removal Action Objectives

Human health risks will be reduced through the reduction of contact between human receptors and COPCs in the Removal Action Area sediments. The reduction of contact will reduce local health risks to acceptable levels. However, exposures from other sources outside of the Removal Action Area will not be affected by action in the Removal Action Area.

4.2.2 Ecological Risks Removal Action Objectives

Similarly, the risks to ecological receptors will be reduced through attenuation of exposure pathways between ecological receptors and the COPCs found in the Removal Action Area sediments. The reduction of exposure pathways will reduce the exposure and effects of COPCs to acceptable levels. However, exposures from other sources outside of the Removal Action Area will not be affected by action in the Removal Action Area.

4.2.3 Recontamination Potential Removal Action Objectives

The Removal Action alternatives will be evaluated based on the extent to which they "reduce the likelihood of recontamination of sediments within the Removal Action Area." Reductions in the potential for post-Removal Action recontamination may be achieved by removing or capping impacted sediment, which could recontaminate other portions of the Removal Action Area through resuspension and redistribution or through the mobilization of dissolved-phase contaminants from sediment to surface water and subsequent redeposition.

Potential ongoing sources of sediment contamination are being evaluated through separate programs, such as the Slip 1 and Slip 3 Upland Source Control Projects for Terminal 4, under DEQ agreements. In addition, offsite sources in the Willamette River are being evaluated through the Portland Harbor Superfund Site RI/FS, which is providing comprehensive ecological and human health risk assessments for the river in Portland Harbor and which, when completed, will result in a USEPA-sponsored plan to remediate sediments and manage risks.

4.3 Other Objectives

In addition to RAOs, other objectives may also be considered during the evaluation of Removal Action alternatives. For the Terminal 4 Removal Action, an additional consideration is the importance of maintaining ongoing operations at Terminal 4. Therefore, the EE/CA work plan (BBL, 2004a) identified the following additional objective:

- Achieve the RAOs while allowing continued use of Terminal 4 as a marine terminal and minimizing the disruption of operations.

The Port operates Terminal 4 as a commercially viable marine terminal within its wide-ranging operations. It is important for the financial well-being of the Port and the community to maintain marine operations at Terminal 4 while meeting environmental cleanup goals. Therefore, maintaining marine operations at Terminal 4 to the maximum extent possible is an important factor to consider when evaluating Removal Action technologies and Removal Action alternatives.

4.4 Summary of Approach to Meeting the Removal Action Objectives

In accordance with the AOC, the Port is committed to pursuing the path set forth in the NTCRA guidance (USEPA, 1993). Accordingly, the Port has conducted a detailed characterization of the Removal Action Area (BBL, 2004b) to gather information for the development and evaluation of Removal Action alternatives. Based on that evaluation, the Port has analyzed applicable removal technologies and is evaluating Removal Action Area-specific characteristics, particularly ARARs, in order to:

- evaluate the Removal Action alternatives against the NTCRA evaluation criteria;
- evaluate the Removal Action alternatives against each other with respect to the criteria; and
- identify a Preferred Alternative that meets the RAOs and is the most suitable alternative with respect to the evaluation criteria.

Section 5 summarizes the results of the screening of potentially applicable Removal Action technologies. Section 6 summarizes the chemical-, location-, and action-specific ARARs. Section 7 describes the Removal Action alternatives in detail. Section 8 presents comparative evaluations of the Removal Action alternatives to the NTCRA criteria and to each other. Section 9 presents the Preferred Alternative and the rationale for its selection.

5. Technology Screening

The Terminal 4 EE/CA work plan (BBL, 2004a) identified general technologies that would be considered for inclusion in the development of Removal Action alternatives. Section 101(23) of CERCLA defines "remove" or "removal" as follows:

> …cleanup or removal of released hazardous substances from the environment; such actions as may be necessary taken in the event of the threat of release of hazardous substances into the environment; such actions as may be necessary to monitor, assess, and evaluate the release or threat of release of hazardous substances; the disposal of removed material; or taking of such other actions as may be necessary to prevent, minimize, or mitigate damage to the public health or welfare of the United States or to the environment, which may otherwise result from a release or threat of release.

In accordance with USEPA guidance (USEPA, 1993) for NTCRAs, "only the most qualified technologies that apply to the media or source of contamination" should be considered for the development of Removal Action alternatives. Based on the definition of removal action under CERCLA and USEPA NTCRA guidance, the technologies identified in the approved EE/CA work plan for consideration in the development of alternatives were:

- monitored natural recovery, which may be applicable to portions of the Removal Action Area with low contaminant concentrations;
- in-situ capping of contaminated sediment; and
- sediment dredging (both mechanical and hydraulic) followed by auxiliary technologies such as transport, treatment, and/or onsite disposal of dredged sediments in a CDF or offsite disposal of dredged sediments.

The Port screened these potentially applicable technologies to identify the technologies that are feasible and implementable and then assembled the Removal Action alternatives to include the screened technologies as components. As discussed in more detail in Section 7, other factors were considered in the development of the alternatives, including the physical, chemical, and operational characteristics of the Removal Action Area and community feedback. The AOC executed by the Port and USEPA in October 2003 required the Port, as part of the Terminal 4 EE/CA process, to prepare a technical briefing for USEPA, DEQ, the Tribes, and the Trustees on the proposed Removal Action alternatives that would be presented in the EE/CA. The Port presented this technical briefing, which included the results of the technology screening process, to USEPA, DEQ, the Tribes, and the Trustees on October 29, 2004. At that time, the Port and USEPA reached general agreement on the Removal Action alternatives that would be evaluated in the EE/CA. The results of the technology screening are presented in Appendix B and summarized below.

5.1 Monitored Natural Recovery

MNR is a fundamental component of the USEPA's Contaminated Sediment Management Strategy (USEPA, 1998) and is a USEPA-accepted technology that has been selected as a primary cleanup method for contaminated sediments at many Superfund sites (USEPA, 2002).

MNR was evaluated for the Removal Action Area (see summary in Appendix B and evaluation in Appendix H) and was found to be feasible in the following subareas, where contaminant concentrations are low:

- a portion of Berth 401;
- a portion of Slip 1;
- a portion of Wheeler Bay; and
- the North of Berth 414 subarea.

Based on these results, MNR was retained as a technology for inclusion in the development of Removal Action alternatives.

5.2 Capping

Capping is a fundamental component of the USEPA's Contaminated Sediment Management Strategy (USEPA, 1998) and is a USEPA-accepted technology that has been selected as a primary cleanup method for contaminated sediments at many Superfund sites (USEPA, 2002).

Capping involves the placement of material on top of the contaminated sediment, thereby isolating chemicals in the sediment from contact with receptors and the aquatic environment. Two general types of sediment caps were screened:

- sand or gravel caps; and
- caps made of synthetic materials, e.g., synthetic (polymer) liners, self-hardening aggregate, concrete-filled fabric mattresses, and two-layer absorbent caps.

Based on the screening results (see summary in Appendix B and evaluation in Appendix I), the types of caps that might be needed to control erosion on steep slopes, such as concrete mattresses, were retained for further consideration during the design phase. Since likely not applicable to the COPCs in the Removal Action Area, absorbent caps were not retained for possible consideration. Sand or gravel caps were retained for further consideration in parts of the Removal Action Area where the slopes are less steep and areas are less exposed to hydraulic forces and erosional impacts. Institutional controls typically used in association with capping will be considered when developing alternatives.

5.3 Dredging, Transport, Treatment, and Disposal

5.3.1 Dredging

Dredging is a fundamental component of the USEPA's Contaminated Sediment Management Strategy (USEPA, 1998) and is a USEPA-accepted technology that has been selected as a primary cleanup method for contaminated sediments at many Superfund sites (USEPA, 2002).

Dredging technologies can generally be placed in one of four broad categories:

- mechanical;
- hydraulic;
- pneumatic; and
- specialized.

Within these categories, several types of dredging equipment were screened (see summary in Appendix B and evaluation in Appendix J). Dredges that are compatible with conditions in the Removal Action Area and that have been widely used for environmental applications are the mechanical open and enclosed clamshell buckets. Their wide availability and applicability make these dredges the more practical choice for dredging in the Removal Action Area if the dredged sediments are disposed of at an offsite landfill. Mechanical clamshell buckets may also be appropriate if the sediments are disposed in a nearby CDF. Hydraulic cutterhead dredges are also well established, widely available, and compatible with site conditions and would also be applicable if a nearby CDF were available to receive the resulting high-water-content dredged material. Advantages of the hydraulic cutterhead dredges include reduced potential for resuspension of sediments, a typically higher production rate, and less sediment rehandling when used in conjunction with CDF disposal. For these reasons, the retained dredging technologies were mechanical dredging using an open clamshell bucket, mechanical dredging using an enclosed clamshell bucket, and hydraulic dredging using a cutterhead dredge.

5.3.2 Transport

Transport technologies commonly applicable to dredging projects are:

- truck transport;
- rail transport;
- barge transport; and
- pipeline transport.

Based on the screening results (Appendix B), all four transport technologies were found to be feasible and none of the technologies was eliminated from consideration for inclusion in the Removal Action alternatives. However, if the dredged material is disposed of in an onsite CDF, barge and pipeline transport are the only applicable transport technologies. Of these, pipeline transport is most desirable, because it is widely available at a relatively low cost, avoids rehandling of the dredged material and so is more protective, and is highly feasible in conjunction with onsite disposal in a CDF. For offsite disposal, truck transport is the least desirable transport mechanism because of its relatively higher cost, greater propensity for vehicular accidents, and the large number of trucks required.

5.3.3 Treatment

As stated in USEPA NTCRA guidance, “whenever practicable, the alternatives selection process should consider the CERCLA preference for treatment over conventional containment or land disposal approaches to address the principal threat at a site” (USEPA, 1993). However, the guidance also states that “Removal actions, however, cannot conform entirely to requirements for remedial actions because of site-related time constraints and statutory limits on remedial actions.” For this reason, “only the most qualified technologies that apply to the media or source of contamination should be discussed in the EE/CA” based on proven treatment technologies that have been “selected in the past at similar sites for similar contaminants” (USEPA, 1993).

The following technology types were screened (Appendix B):

- thermal treatment;
- extraction;
- chemical treatment;
- biological/bioremediation; and
- immobilization.

Based on the results of the screening analysis, no treatment technology was retained for inclusion in the development of Removal Action alternatives because:

- The cost of treatment is relatively high.

- Sediments exhibiting contamination by multiple chemicals would require multiple treatment technologies.

- Processing the dredged material would significantly extend the project’s duration, since treatment could not occur at the same rate as dredging.

- There is no Oregon market for treatment end products, which would therefore require disposal, and gaining approval to market the end product would require a regulatory process.

- For treatment technologies to be economical, a minimum volume of 100,000 cy per year over a 10- to 20-year period is typically required. The volume of dredged sediment from the Removal Action Area will be approximately 10% to 20% of the necessary volume for cost-effective treatment. Moreover, the Removal Action is a one-time event and so does not justify the high capital cost of treatment systems.

- Of the seven vendors surveyed, no vendor of a process with potential applicability to the Removal Action Area sediments was interested in pursuing a project of this limited size and duration.

- As discussed in Appendix B, it was considered whether a treatment plant serving all sites within Portland Harbor would be economically feasible. Considering the present state of sediment treatment technologies it is unlikely that a technology capable of treating all potential contaminants will become available within the timeframe of the Portland Harbor cleanup process.

5.3.4 Disposal

Two disposal technologies were evaluated for dredged sediments from Terminal 4:

- onsite disposal in a CDF; and
- offsite disposal at a USEPA-approved landfill.

In addition, the materials handling options of dewatering and stabilization with a drying agent were screened as potential technologies that may be considered to facilitate transport and disposal of dredged sediment. All of these technologies were retained for inclusion in the development of Removal Action alternatives. The screening of disposal options is summarized in Appendix B; Appendix K provides an evaluation of CDF feasibility. Institutional controls typically used in conjunction with CDFs will be considered when developing alternatives.

5.4 Summary of Technology Screening

Appendix B presents the results of the technology screening conducted to identify technologies potentially applicable to the Terminal 4 Removal Action. The screened technologies are MNR, capping, and dredging followed by associated transport, treatment, and/or onsite or offsite disposal technologies. Based on the analysis presented in Appendix B, most of these technologies were found to be effective, implementable, and applicable to the characteristics of Terminal 4 in whole or in part. In particular:

- Monitored natural recovery was found to be feasible at portions of Berth 401, Wheeler Bay, and Slip 1 and at the North of Berth 414 subarea.

- Capping was found to be feasible for both slips. The types of caps that might be needed to control erosion on steep slopes, such as concrete mattresses, were retained for further consideration during the design phase. Absorbent caps were not retained; because an absorbent cap is not likely to be applicable to the COPCs in Terminal 4 sediments. Sand or gravel caps were retained for further consideration in parts of the Removal Action Area where the slopes are less steep and areas are less exposed to hydraulic forces and erosional impacts.

- Dredging was found to be feasible for both slips. The specific technology types with greatest applicability to conditions at Terminal 4 are mechanical dredging using an open clamshell bucket, mechanical dredging using an enclosed clamshell bucket, and hydraulic dredging using a cutterhead dredge.

- The transport technologies of truck, rail, barge, and pipeline are all feasible and none of the technologies was eliminated from consideration for inclusion in the Removal Action alternatives. However, if the dredged material is disposed of in an onsite CDF, barge and pipeline transport are the only applicable transport technologies.

- Treatment was not found to be feasible for the conditions prevailing at Terminal 4. No treatment technology was retained for inclusion in the development of Removal Action alternatives because the cost of treatment is relatively high, there is no Oregon market for the end product, and none of the surveyed vendors offering a process with potential applicability to the Removal Action Area sediments was interested in pursuing a project of this limited size and duration. Therefore, sediment treatment technologies were not considered in the development of Removal Action alternatives.

- Both offsite disposal at a USEPA-approved landfill and onsite disposal in a CDF were found to be feasible and were considered in the development of Removal Action alternatives. Dewatering and stabilization with a drying agent were retained as materials handling technologies that may be considered to facilitate transport and disposal of dredged sediment.

6. Potential ARARs and TBCs

This section identifies the applicable or relevant and appropriate requirements (ARARs) that may govern the Removal Action at Terminal 4.

6.1 The ARAR Process

CERCLA 121(e) exempts remediation actions conducted entirely onsite from having to comply with administrative requirements such as obtaining permits and meeting reporting and recordkeeping requirements. Thus, no federal, state, or local permits are required for onsite actions associated with the Removal Action at Terminal 4 [40 CFR 300.400(e)(1)]. The National Contingency Plan (NCP) defines onsite as "the areal extent of contamination and all suitable areas in very close proximity to the contaminants necessary for implementation of the response action." Areal extent of contamination refers to surface area, groundwater beneath the site, and air above the site. Offsite actions (e.g., offsite disposal of hazardous waste) must comply with all legally applicable substantive and administrative requirements, including obtaining permits. The concept of relevant and appropriate is not available to offsite locations.

For onsite actions, USEPA and support agencies must identify the legally applicable or relevant and appropriate requirements that may govern the removal action. Legally applicable requirements include those requirements promulgated under federal or state law or state facility siting law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at Terminal 4. Examples of legally applicable requirements include cleanup standards, standards of control, and other environmental protection requirements, criteria, or limitations. Relevant and appropriate requirements are requirements for environmental protection promulgated under federal or state law that address situations sufficiently similar to the circumstances of the removal action contemplated and are well-suited to Terminal 4 [40 CFR 300.400(g)(1) and (2)].

In addition, to qualify as an ARAR a state requirement must be:

- a state law;
- promulgated under a federal or state environmental or facility siting law;
- more stringent than the federal requirement;
- identified by the state in a timely manner; and
- consistently applied.

6.2 ARAR Classifications

CERCLA actions may have to address several types of requirements. USEPA developed ARARs classifications to provide guidance on how to identify and address ARARs. There are three ARAR classifications:

- chemical-specific;
- location-specific; and

- action-specific.

These classifications are defined below.

- Location-specific requirements are restrictions on activities based on the characteristics of a site or its immediate environment. The restrictions on work performed in wetlands or wetland buffers provide an example in which location-specific requirements may require restoration of wetlands.

- Chemical-specific requirements are health- or risk-based concentration limits or ranges for specific hazardous substances, pollutants, or contaminants in various environmental media. An example is the maximum contaminant levels established by USEPA as safe levels in drinking water.

- Action-specific requirements are controls or restrictions on particular types of activities such as hazardous waste management or wastewater treatment. Examples of action-specific requirements are state and federal air emissions standards as applied to an in-situ extraction treatment unit.

The potential location-, chemical- and action-specific ARARs for the Removal Action are identified in Table 6-1. Federal, state, and local permits are required for any offsite actions and are addressed in the administrative feasibility section for each Removal Action alternative.

6.3 To Be Considered

The USEPA has developed another category of requirements called "to be considered" (TBCs), which includes non-promulgated criteria, guidance, and proposed standards issued by federal or state governments. TBCs are not promulgated or enforceable. Identification of and compliance with TBCs are not mandatory in the same way they are for ARARs.

TBC materials as defined by the NCP are non-promulgated advisors, criteria, or guidance developed by USEPA, other federal agencies, or states that are not legally binding and do not have the status of potential ARARs. However, where no promulgated cleanup levels or standards exist, they may be useful in helping to determine the necessary level of cleanup or standard of control that is protective of human health and the environment, as well as how to carry out certain actions or requirements. Potential TBCs are also included in Table 6-1.

Table 6-1 Potential ARARs for Monitored Natural Attenuation, Capping, Dredging, and Confined Disposal Facility			
Regulation	**Citation**	**Criterion/Standard**	**Applicability/Appropriateness**
Federal ARARs			
Clean Water Act, Section 404	33 USC 1344 33 CFR Parts 320-323 40 CFR 230	Regulates discharge of dredged and fill material into waters of the United States.	Action-specific. Potentially applicable to dredging, covering and capping activities.
Clean Water Act, Ambient Water Quality Criteria	33 USC 1313, 1314 40 CFR Part 131	Provides minimum standards for water quality programs established by states. Two kinds of water quality criteria exist: one for protection of human health, and one for protection of aquatic life.	Chemical-specific, action-specific. Potentially relevant and appropriate to short-term impacts from implementation of the removal action and as a performance standard for the removal action for surface water quality if more stringent than promulgated state criteria.
Clean Water Act, Section 401	33 USC 1341	Applies to any activity which may result in any discharge into navigable waters and requires that such discharge comply with state water quality standards.	Chemical-specific, action specific. Potentially applicable if removal action results in a discharge into the river (i.e. during dredging and capping activities and during in-water disposal activities).
Clean Water Act, Section 402	33 USC 1342	Authority for implementing the regulations, limitations, and standards promulgated under Sections 301, 302, 306 and 307 of the Clean Water Act (technology-based and water-quality based effluent standards for conventional and toxic pollutants applicable to point source discharges).	Oregon implements federally-authorized program for point source discharges. See State ARARs, State Water Quality Standards below.
Resource Conservation	42 USC 6901 et seq	Establishes identification and management	Chemical-specific, action-specific; state of

Table 6-1
Potential ARARs for Monitored Natural Attenuation, Capping, Dredging, and Confined Disposal Facility

Regulation	Citation	Criterion/Standard	Applicability/Appropriateness
and Recovery Act	40 CFR 260, 261	standards for solid and hazardous waste.	Oregon implements federally-authorized program. See State ARARs below.
Hazardous Materials Transportation Law and Regulations	49 USC 5101 et seq. 19 CFR 171-173	Requirements for transportation of hazardous materials, including classification, packaging, labeling, inspection of containers, loading and unloading techniques, training requirements.	Chemical-specific Potentially applicable.
Fish and Wildlife Coordination Act Requirements	16 USC 662, 663 40 CFR 6.302(g)	Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways.	Location specific, action specific. Potentially applicable.
Magnuson-Stevens Fishery Conservation and Management Act	50 CFR Part 600	Evaluation of impacts to Essential Fish Habitat (EFH) is necessary for activities that may aversely affect EFH.	Location-specific; action-specific Potentially applicable.
National Historic Preservation Act	16 USC 470 et seq. 36 CFR Part 800	Requires the identification of historic properties potentially affected by the agency undertaking, and consultation to assess the effects on the historic property and seek ways to avoid, minimize or mitigate such effects. Historic property is any district, site, building, structure, or object included in or eligible for the National Register of Historic Places, including artifacts, records, and material remains related to such a property.	Location specific; action specific. Potentially applicable if historic properties are potentially affected by the proposed undertaking.
Native American Graves Protection and Reparation Act	25 USC 3001-3013 43 CFR 10	Requires Federal agencies and museums which have possession of or control over Native American cultural items (including human remains, associated and unassociated funerary items, sacred objects and objects of cultural patrimony) to compile an inventory of	Location-specific; action specific If Native American cultural items are present on property belonging to the Oregon Division of State Lands (DSL), this requirement is potentially applicable to the

Table 6-1 Potential ARARs for Monitored Natural Attenuation, Capping, Dredging, and Confined Disposal Facility			
Regulation	**Citation**	**Criterion/Standard**	**Applicability/Appropriateness**
		such items. Prescribes when such Federal agencies and museums must return Native American cultural items. "Museums" are defined as any institution or State or local government agency that receives Federal funds and has possession of, or control over, Native American cultural items.	State of Oregon's management of those cultural items. If Native American cultural items are collected by an entity which is either a federal agency or museum, then the requirements of the law are potentially applicable.
Endangered Species Act	16 USC 1531 et seq.	Actions authorized, funded, or carried out by federal agencies may not jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their critical habitats. On April 30, 2002, the US District Court for the District of Columbia entered a consent decree signed by NOAA Fisheries vacating and remanding critical habitat designations for certain species, including critical habitat in the lower Willamette. 68 Fed. Reg. 55900. While there is currently no designated critical habitat for fish species affecting the RAA, on December 14, 2004, NOAA Fisheries proposed to designate critical habitat for certain species of fish in the lower Willamette sub-basin. 68 Fed. Reg. 74572 (Dec. 14, 2004). The new rule may or may not affect the RAA.	Action-specific, location specific. Potentially applicable.
Executive Order for Wetlands Protection	Executive Order 11990 (1977) 40 CFR 6.302 (a)	Requires measures to avoid adversely impacting wetlands whenever possible, minimize wetland destruction, and preserve	Action-specific, location specific. Potentially relevant and appropriate.

Table 6-1 Potential ARARs for Monitored Natural Attenuation, Capping, Dredging, and Confined Disposal Facility			
Regulation	**Citation**	**Criterion/Standard**	**Applicability/Appropriateness**
	40 CFR Part 6, App. A	the value of wetlands.	
Executive Order for Floodplain Management National Flood Insurance Act and Flood Disaster Protection Act	Exec. Order 11988 (1977) 40 CFR Part 6, App. A 40 CFR 6.302 (b) 42 U.S.C 4001 et seq. 44 CFR National Flood Insurance Program Subpart A Requirements for Flood Plain Management Regulations Areas	Requires measures to reduce the risk of flood loss, minimize impact of floods, and restore and preserve the natural and beneficial values of floodplains.	Location-specific, action-specific. Potentially relevant and appropriate.
Rivers and Harbors Act	33 USC 403 33 CFR 320-330	Regulates activity that may obstruct or alter a navigable waterway, including: (1) creating any obstruction to the navigable capacity, (2) building any wharf, boom, weir, breakwater, bulkhead, jetty, or other structure within the area of federal jurisdiction (between and below the ordinary high water marks); and (3) filling, altering or modifying the course, location, condition or capacity of the river.	Action-specific Potentially applicable. No permit required for on-site activities.
Migratory Bird Treaty Act	16 USC 703-702 50 CFR 10.12	Makes it unlawful to take, import, export, possess, buy, sell purchase, or barter any migratory bird. "Take" is defined as pursuing, hunting, shooting, poising, wounding, killing, capturing, trapping and collecting.	Action-specific Potentially relevant and appropriate to short-term impacts from removal activities.
State ARARs			

Table 6-1 Potential ARARs for Monitored Natural Attenuation, Capping, Dredging, and Confined Disposal Facility			
Regulation	**Citation**	**Criterion/Standard**	**Applicability/Appropriateness**
Hazardous Waste Regulations	ORS 466.005-225, OAR 340-101-0033	Federally authorized state of Oregon hazardous waste identification and management program that operates in lieu of the base federal program. (Oregon: Final Authorization of State Hazardous Waste Management Program – Revision (September 10, 2002), 67 Fed. Reg. 57337).	Chemical-specific Potentially applicable to material removed and sent off-site for disposal.
Oregon Hazardous Substance Remedial Action Law and Regulations	ORS 465.200-465.420, OAR 340-122-010 et seq.	Establishes cleanup authority and objectives, and criteria applicable to hazardous substances defined to include oil and other petroleum products. Includes authority and requirements applicable to removal actions that are patterned after CERCLA; enforces criteria very similar to those required by the National Contingency Plan to the extent they are more stringent or broader in scope than CERCLA; ORS 465.315(1)(b)(A) and (1)(e) provide standards for degree of cleanup.	Chemical-specific Potentially applicable to extent more stringent or broader in scope than federal law.
State Removal Fill Law and Regulations	ORS 274.040, 0.43,.922, .944 OAR 141-85-0001 et seq; OAR 141-85-0115, 0121, 0126, 0136, 0141, 0151 and 0171	Regulates activities associated with removal and fill operations in state waters, including requirements for wetland mitigation.	Action-specific Potentially relevant and appropriate. No permit required.
Certification of Compliance with Water Quality Requirements and Standards	ORS 468b.035 OAR 340-048-	Defines state mechanism for certifying actions comply with water quality standards.	Chemical-specific Potentially relevant and appropriate to short-term impacts from implementation of

Table 6-1 Potential ARARs for Monitored Natural Attenuation, Capping, Dredging, and Confined Disposal Facility			
Regulation	**Citation**	**Criterion/Standard**	**Applicability/Appropriateness**
			the removal action.
Indian Graves and Protected Objects	ORS 97.740-760	Prohibits willful removal of cairn, burial, human remains, funerary object, sacred object or object of cultural patrimony. Provides for reinterment of human remains or funerary objects under the supervision of the appropriate Indian tribe. Proposed excavation by a professional archeologist of a native Indian cairn or burial requires written notification to the State Historic Preservation Officer and prior written consent of the appropriate Indian tribe	Location specific; action-specific. Potentially relevant and appropriate if archeological materials encountered.
Archaeological Objects and Sites	ORS 358.905-955	Prohibits persons from excavating, injuring, destroying or damaging archaeological sites or objects on public or private lands unless authorized by permit.	Location specific; action-specific. Potentially relevant and appropriate if archeological material encountered.
Requirements regarding Excavation or Removal of Archaeological or Historical Material on Public Lands	ORS 390.235 OAR 736-051-0060 to 736-051-0090.	Requires permits and imposes conditions for excavation or removal of archaeological or historical materials.	Location-specific; action-specific. Potentially relevant and appropriate if archeological material encountered.
State Water Quality Standards	ORS 468B.048; OAR ch 340 div 41	Provides Willamette Basin beneficial uses and establishes water quality standards and criteria to protect beneficial uses.	Chemical-specific, action-specific Potentially relevant and appropriate to short-term impacts from implementation of the removal action; relevant and appropriate as performance standards and

Table 6-1
Potential ARARs for Monitored Natural Attenuation, Capping, Dredging, and Confined Disposal Facility

Regulation	Citation	Criterion/Standard	Applicability/Appropriateness
			long-term monitoring of the removal action for surface water quality in the removal action area.
State Air Quality Law and Noise Control	ORS 468A OAR 340-226-0100, OAR 340-035-0035	Provides general emission standards for fugitive emissions of air contaminants and requires the highest and best practicable treatment of control of such emissions. Prohibits any handling, transporting or storage of materials, or use of a road, or any equipment to be operated, without taking reasonable precautions to prevent particulate matter from becoming airborne. Sets noise standards for equipment, facilities, operations, or activities employed in the production, storage, handling, sale purchase, exchange or maintenance of a product, commodity, or service, including the storage or disposal of waste products.	Action-specific Potentially relevant and appropriate to certain activities during implementation of the removal action.
State Essential Indiginous Salmonid Habitat	ORS 196.810(b) OAR 141-102	Designates Essential Salmonid Habitat and regulates activities affecting such habitat.	Location-specific Potentially relevant and appropriate.
Lower Willamette River Management Plan	ORS 273.045 OAR 141-080-0105	Department of State Lands (DSL) plan regulating leasing, license, and permit activities in the lower Willamette River. The plan describes allowable activities and conditions for waterway management areas based on state public trust values (fisheries,	Location-specific. Potentially relevant to activities performed on DSL land.

Table 6-1 Potential ARARs for Monitored Natural Attenuation, Capping, Dredging, and Confined Disposal Facility			
Regulation	**Citation**	**Criterion/Standard**	**Applicability/Appropriateness**
		recreation, and navigation).	
ODFW Fish Management Plans for the Willamette River.	OAR 635, div 500.	Provides basis for in-water work windows in the Willamette River.	Location-specific; action-specific. Potentially applicable to implementation of the removal action.
Other Criteria, Advisories, Guidance and To Be Considered Initiatives			
Willamette Basin Program	ORS 536.300, 340 OAR 690-52	Requires development of plans to maintain stream flow, promote in-stream uses and values, and meet public needs.	Potentially relevant to the removal action.

7. Identification of Removal Action Alternatives

This section describes the Removal Action alternatives, including a summary of the process by which the alternatives were developed. For each of the five subareas within the Removal Action Area, chemical, physical, and operational characteristics were identified. On the basis of those characteristics, applicable technologies – monitored natural recovery, sediment capping, and/or sediment dredging with onsite or offsite disposal – were determined for each subarea. The Removal Action alternatives were then assembled using those technologies as components. The Removal Action alternatives are described in detail in Section 7.3. This section concludes with a description of the ongoing public involvement process regarding the development of the Removal Action alternatives and execution of the Terminal 4 Removal Action. Following this section, Section 8 provides an analysis of the Removal Action alternatives in terms of their effectiveness, implementability, and costs.

7.1 Attributes of the Removal Action Area

The applicability of technologies depends not only on chemical characteristics of the Removal Action Area, but also on its physical and operational characteristics. Chemical characteristics of the Removal Action Area are discussed extensively in the characterization report (BBL, 2004b) and in Appendix E. Physical characteristics, which include engineering characteristics, are also discussed in detail in the characterization report (BBL, 2004b) and in Appendix C, including topography, slopes, surface covering, existing buildings, adjacent structures, and other fixtures. Operational characteristics include such considerations as current and future marine and business uses, vessel traffic, and ongoing construction and environmental cleanup.

Within the Removal Action Area, five subareas have been identified on the basis of their differences in chemical, physical and operational characteristics:

- Berth 401;
- Slip 1;
- Wheeler Bay;
- Slip 3; and
- North of Berth 401.

Figure 7-1 presents the approximate boundaries of these subareas. Figure 7-2 shows the flow of cargo within the subareas.

The chemical, physical, and operational attributes of the five subareas were considered during the development of Removal Action alternatives to aid in identifying applicable technologies; these attributes are summarized by subarea in Sections 7.1.1 (Berth 401), 7.1.2 (Slip 1), 7.1.3 (Wheeler Bay), 7.1.4 (Slip 3), and 7.1.5 (North of Berth 414). Section 7.2 describes how the retained technologies (refer to the technology screening in Appendix B) were applied to the subareas. Section 7.3 then describes the Removal Action alternatives that were assembled on the basis of this information.

7.1.1 Berth 401

7.1.1.1 Chemical Characteristics

No sediment samples from the Berth 401 subarea exhibited PEC exceedances. Detected TEC exceedances demonstrate that detected contaminants in Berth 401 were encountered at relatively shallow depths. The maximum depth at which detected contaminants were encountered in samples recovered at Berth 401 is approximately 3 feet.

7.1.1.2 Physical Characteristics

Berth 401 is approximately 3.5 acres in area with a relatively steep slope. Berth 401 consists of a T-shaped finger pier (refer to Figure 7-1) that would limit access for dredging and capping equipment, making dredging and capping beneath the pier structure extremely difficult.

The Berth 401 pier occupies a long section along the length of the Berth 401 area. Dolphins are connected to the pier by catwalks at the pier's north and south ends. The dolphins are used to secure vessels and barges to the pier. A row of closely spaced piles is located east of the pier (i.e., behind the pier). Many areas in the Berth 401 subarea are covered with riprap and there are remnants of old structures. Two stormwater outfalls are located within the Berth 401 subarea.

7.1.1.3 Operational Characteristics

Although no tenant currently uses Berth 401, grain export has been performed via Berth 401 in the past (refer to Figure 7-2). The Port is conducting a redevelopment evaluation of the grain terminal to market the facility for continued use. Berth 401 is currently used for lay vessel storage.

7.1.1.4 Applicable Technologies

Capping at Berth 401 is generally feasible, although capping in the under-pier areas would be extremely difficult because of fairly tight pile spacing and could require special equipment. In addition, the design of the cap would have to address the potential for penetration of the cap by the piles; Berth 401 is an active berth where pile replacement activities would occur routinely. Dredging beneath the Berth 401 pier structure is not feasible because of the tight pile spacing. However, dredging is generally feasible in the areas surrounding the pier structure, although existing riprap, remnants of old structures, and limited access would present difficulties. For either capping or dredging, the areas behind the pier might have to be accessed from the upland side using special long-reach excavators or other specialized equipment.

MNR is considered feasible in areas where contaminant concentrations are low. Marginal PCB concentrations were encountered at the north end of the Berth 401 area (VC01). Capping or dredging in this area is generally feasible.

Given the considerations described above, the following technologies are generally applicable at Berth 401:

- MNR, excepting an area at the north end of the Berth 401 area;
- capping; and
- a combination of dredging and capping (i.e., capping of the under-pier area).

7.1.2 Slip 1

7.1.2.1 Chemical Characteristics

Contamination in Slip 1 is somewhat spotty and relatively shallow. A relatively small area in front of Berth 405 shows TEC exceedances up to a depth of 7 feet below mudline. The depth at which detected contaminants were encountered is between 0 and 3 feet in most other areas of Slip 1, with the exception of an area toward the southwest end of the slip, where the depth is about 5 feet.

7.1.2.2 Physical Characteristics

The total area of Slip 1 is approximately 17.2 acres. Approximately half of this area is on relatively steep slopes. The under-pier areas are generally covered with riprap. The slope area along the south slope, west of Berth 408, has experienced surficial instabilities in the past and may require regrading or similar measures to increase slope stability. Slip 1 is considered a possible location for a CDF.

All existing pier structures are located near the head of Slip 1, at Berths 405 and 408. . The final remaining warehouse structures (warehouses 1 and 2) have been demolished. The decking and pier structure related to these warehouses were left in place. A barge leg is used to transport bulk grain from barges to the adjacent grain facility via a conveyor. Another pile-supported pier structure is located at Berth 408 on the south side of the slip. Six stormwater outfalls are located around the perimeter of Slip 1.

7.1.2.3 Operational Characteristics

Berth 405 is used for barge unloading to the grain facility barge leg on the north side of Slip 1 (refer to Figure 7-2), although the berth is not currently in use. International Raw Materials (IRM) uses Berth 408 for bulk liquid offloading on the south side of the slip.

7.1.2.4 Applicable Technologies

MNR is applicable only in areas of Slip 1 having low contaminant concentrations, such as at the mouth of the slip and along the eastern portion of the north slope.

Slip 1 is considered a potential site for construction of a CDF that could receive dredged sediments from Terminal 4 and other sources. If an at-grade CDF were constructed, the remaining piers would have to be demolished and the grain facility barge leg (Berth 405) and IRM barge loading (Berth 408) would have to be relocated. Outfalls would also have to be relocated.

Capping and dredging in Slip 1 are generally considered feasible. However, under-pier capping at Berths 405 and 408 is not considered feasible unless the piers are demolished at least to the pile caps. Dredging in Slip 1 is feasible and would also require demolition of the pier structures and warehouses. Due to vessel activity in the slip, some cap armoring will likely be necessary in areas subject to propeller scour.

Given the considerations described above, the following technologies are generally applicable in Slip 1:

- MNR in the northwest portion of Slip 1 and at the mouth of the slip;
- capping;
- dredging with offsite (i.e., landfill) disposal;
- a combination of dredging and capping; and
- a CDF.

7.1.3 Wheeler Bay

7.1.3.1 Chemical Characteristics

Contaminants were detected at variable depths, extending from the surface to beyond 22 feet below the mudline. There are multiple TEC exceedances for zinc, PAHs, and DDT. In addition, there is one PEC exceedance for zinc and one for PAHs, detected in samples VC18 and VC19, respectively. These samples were collected on the slope along the shoreline.

7.1.3.2 Physical Characteristics

Wheeler Bay is approximately 7 acres in area. Some portions of the shoreline are steep. A beach area exists at higher elevations near the ordinary high water (OHW) level.

The Berth 410 finger pier separates Wheeler Bay from Slip 3 along the south side of the bay. This finger pier is an open structure that allows water and sediment to move through between the piles. The Port has installed a sheet pile bulkhead along the south side of the finger pier to facilitate dredging to the authorized depth, accommodate dredging for the Removal Action, and stabilize an over-steepened under-pier slope at Berths 410/411. The remnant of a small pier structure and one stormwater outfall are located within the Wheeler Bay subarea.

7.1.3.3 Operational Characteristics

No tenants currently use Wheeler Bay. Marine service providers use the bay to temporarily tie up to the back of the Berth 410 finger pier (refer to Figure 7-2). The City of Portland owns a portion of the upland adjacent to Wheeler Bay.

7.1.3.4 Applicable Technologies

Contaminants were detected from the surface to beyond 22 feet below the mudline. Dredging to these depths would cause significant technical difficulties for two reasons. First, the stability of the pile foundations of the Berth 410 finger pier may be affected by deep dredging, necessitating stabilization measures that could be complex and costly. Second, the upland areas and slopes along the waterfront on Wheeler Bay would be undermined by deep dredging in the bay, necessitating extensive slope regrading and/or the potential loss of upland property. Since the Port has facilities on the upland area and is currently designing a rail yard for the area along the top of the bank, loss of land is not acceptable to the Port. Dredging would require extensive and costly bank stabilization efforts to protect the upland area. Therefore, dredging in Wheeler Bay is not considered a feasible Removal Action technology.

Capping is considered generally feasible within Wheeler Bay. Scour protection would have to be placed in areas with frequent vessel traffic to protect the cap from erosion.

MNR is considered feasible in areas having low contaminant concentrations. In the area along the shoreline where elevated PAH concentrations and a PEC exceedance for zinc were encountered, capping is generally feasible.

Given the considerations described above, the following technologies are generally applicable at Wheeler Bay:

- MNR, with the exception of an area along the shoreline of Wheeler Bay; and
- capping.

7.1.4 Slip 3

7.1.4.1 Chemical Characteristics

Contaminants were generally detected at depths between 2 and 5 feet below the mudline. No TEC or PEC exceedances for PCBs were detected in Slip 3. PEC exceedances for zinc and PAHs were detected in the eastern half of Slip 3, toward the head of the slip. A few samples near the river exhibited TEC exceedances for PAHs, but no zinc exceedances were encountered in this area. TEC exceedances for DDT were mainly detected toward the head of the slip, but a few samples collected near the river also exhibited TEC exceedances.

7.1.4.2 Physical Characteristics

The total area of Slip 3 is about 14.4 acres, including slope areas up to the OHW level. The bottom of the slip represents approximately 9.1 acres of the total, while the adjacent slopes represent approximately 5.3 acres, including 0.7 acre under the Berth 410 finger pier and 1.7 acres under the Berth 411 pier structure. Slopes are generally steeper at the head of the slip (east slope) and along Pier 5 (south slope).

The area adjacent to the Berth 410/411 pier structure (Pier 4) is frequently dredged to maintain ship access. A sheet pile wall has been installed along the pier, below the water line, to facilitate dredging to the authorized depth, accommodate dredging for the Removal Action, and stabilize an over-steepened under-pier slope at Berths 410/411.

The sheet pile wall extends from the west end of Berth 410 to the east end of Berth 411, where it takes a turn along the shoreline at the head of Slip 3 and extends to about the halfway point between the slip's north and the south slopes. Because Pier 5 along the south side of Slip 3 is no longer used and has been demolished, the slip is actually deeper along active Pier 4 (Berths 410/411). The bottom of Slip 3 toward Pier 5 is at approximate elevation -40 feet. The depth along Pier 4 varies between approximately elevation -40 feet adjacent to Berth 410 to elevation -50 feet adjacent to Berth 411. The deeper area adjacent to Berth 411 is caused by propeller scour from ships that leave under their own power.

The deck and pile caps of the former Pier 5 structure along the south slope of the slip were removed years ago. Approximately 5,000 old timber piles remain in place. An existing pinch pile bulkhead is located at the head of the slip, and three active stormwater outfalls are located near the head of Slip 3. Three additional outfalls that were formerly associated with active systems are located on the south bank of Slip 3, in the vicinity of Pier 5. The drainage system in the vicinity of Pier 5 was revised during upgrades made to the Toyota facility, and these three outfalls are no longer components of any active stormwater management systems for this area.

7.1.4.3 Operational Characteristics

Slip 3 is an active slip. Berths 410 and 411 at Pier 4 on the north side of the slip accommodate ships at an approximate occupancy rate of 70%. The Port has recently negotiated a long-term lease renewal with Kinder Morgan, including options to further extend the lease. Kinder Morgan uses a fixed loader, which necessitates the movement of ships back and forth along Pier 4 during loading operations. The eastern side of the slip (Pier 5) is not in use.

7.1.4.4 Applicable Technologies

Based on contaminant concentrations, the eastern portion of Slip 3 would either have to be dredged or capped. Because ship access to Berths 410/411 must be maintained, capping of the bottom of the slip is not feasible; the bottom of Slip 3 would have to be dredged. Dredging at Berths 410/411 is limited to -43 +2 feet (CRD) based on the design of the sheet pile wall. Dredging to a deeper elevation, if necessary, may be possible with sequential dredging and buttressing in front of the wall.

Capping is considered generally feasible along the slope areas. Dredging on the under-pier slope at Berth 411 is not regarded as feasible due to access limitations under the pier. In addition, this slope is relatively steep and dredging could cause loss of slope stability. Therefore, this area would have to be capped. Although dredging along the south slope is generally feasible, there are many difficulties; therefore, capping appears to be the better solution to avoid slope instability. At the head of the slip, dredging in front of the timber pinch pile bulkhead south of the Berth 411 sheet pile wall could lead to a loss of slope stability. Therefore, capping also appears to be the appropriate technology in this area.

Limited dredging in front of the sheet pile wall segment could be accomplished pending verification testing followed by armoring. Dredging behind the timber pinch pile bulkhead appears to be marginally feasible from a technical perspective. MNR is considered applicable only for the under-pier area at Berth 410, where contaminant concentrations are low.

Given the considerations described above, the following technologies are generally applicable in Slip 3:

- MNR under the pier at Berth 410; and
- a combination of dredging and capping (cap slopes and dredge bottom of Slip 3).

7.1.5 North of Berth 414

7.1.5.1 Chemical Characteristics

In the North of Berth 414 subarea, contaminants were detected at variable depths, extending from the surface to beyond 22 feet below the mudline. Sediment samples exhibited TEC exceedances for PAHs and DDT; no PEC exceedances were detected.

7.1.5.2 Physical Characteristics

The North of Berth 414 subarea is approximately 3 acres in area. The entire area is sloped and exposed to the river. The slopes are relatively steep and armored. There are approximately 150 old piles above elevation 0 feet along the shoreline (see Figure 1-3). The North of Berth 414 subarea contains a dolphin, a catwalk, and one stormwater outfall.

7.1.5.3 Operational Characteristics

Tugboats and other marine service providers frequently tie up to a dolphin at the north end of the Berth 414 area. A catwalk connects the dolphin with the shore.

7.1.5.4 Applicable Technologies

Contaminants were detected from the surface to beyond 22 feet below the mudline. Dredging to these depths could undermine the slopes, necessitating extensive reinforcement of the slopes or regrading, which could result in the loss of land. Dredging could also adversely impact the stability and serviceability of the dolphin at the south end of the Berth 414 area. Therefore, dredging at Berth 414 is not considered a feasible Removal Action technology.

Capping is considered generally feasible within this subarea. Scour protection would have to be placed in areas with frequent vessel traffic to protect the cap from erosion.

MNR is considered feasible for the North of Berth 414 subarea because of relatively low contaminant concentrations.

Given the considerations described above, the following technologies are generally applicable at the North of Berth 414 subarea:

- MNR; and
- capping.

7.2 Application of Technologies to Subareas and Alternatives Development Process

In accordance with the NTCRA guidance (USEPA, 1993), a limited number of alternatives should be identified and assessed based on the nature and extent of contamination and on their ability to address the RAOs. The guidance document states that "only the most qualified technologies that apply to the media or source of contamination should be discussed" (USEPA, 1993).

The nature and extent of contamination is described in the characterization report (BBL, 2004b), summarized in Appendix E, and briefly highlighted by subareas in Section 7.1. RAOs are summarized in Section 4. Section 7.1 discussed the applicability of the candidate technologies to each of the subareas. This section discusses how the applicable technologies were combined to develop the Removal Action alternatives presented in Section 7.3.

Given that there are five subareas and several variations of applicable technologies, the number of possible technology combinations to satisfy RAOs for the Removal Action Area as a whole is large. In accordance with the guidance, four most qualified alternatives were selected to represent a cross section of the possible combinations of technology types:

1. MNR emphasis;
2. capping emphasis;
3. dredging emphasis with CDF disposal; and
4. dredging emphasis with landfill disposal.

Each alternative is made up of a combination of technologies, and certain features were found to apply to all alternatives, as discussed below. For certain subareas, only one applicable technology appeared feasible (see Section 7.1); in those cases, that combination is included in each alternative.

MNR is considered applicable along the waterfront in subareas Berth 401, Wheeler Bay, and the North of Berth 414, as well as in the area at the mouth of Slip 1. While contaminants are found at detectable levels in sediments in these areas, concentrations are low and further removal or capping is not expected to significantly reduce risk. Modeling of natural recovery in these areas suggests that contaminant concentrations will decline once the Removal Action is complete and potential upstream sources have been controlled. For this reason, MNR should be a component of all alternatives in these marginal areas, i.e., MNR will be used in 24% to 26% of the Removal Action Area in most alternatives; in the MNR emphasis alternative, an additional area of MNR would be included in Slip 1.

Two relatively small areas within the Berth 401 subarea and in Wheeler Bay are likely not suitable for MNR because of elevated contaminant concentrations. Because dredging is considered impractical in these areas as well, capping is considered as a component of all Removal Action alternatives.

In Slip 3, MNR is generally appropriate at the mouth of the slip because of low contaminant concentrations; however, because this area is subject to periodic maintenance dredging, MNR is not proposed. On the side slopes in Slip 3, dredging would be relatively difficult for technical and operational reasons; therefore, capping is considered for these areas in all alternatives.

A number of technologies, including construction of a CDF, are applicable in Slip 1. Areas toward the head of the slip and at the southwest side of the slip showed significant contamination. For Slip 1, the Removal Action alternatives therefore consider capping, dredging, and the construction of a CDF. Because of low contaminant concentration, MNR is applicable at the mouth of the slip and in an area at the northwest side of the slip.

7.3 Description of Alternatives

Based on the rationale provided in Section 7.2, the following five Removal Action alternatives have been developed:

- No Action Alternative;
- Alternative A – MNR Emphasis;
- Alternative B – Cap Emphasis;
- Alternative C – Dredge Emphasis with CDF Disposal; and
- Alternative D – Dredge Emphasis with Landfill Disposal.

The following subsections detail how each of the four active Removal Action alternatives would be applied within each of the five subareas.

7.3.1 No Action Alternative

The No Action alternative serves as a baseline against which overall effectiveness of the active Removal Action alternatives can be compared, as required under CERCLA and the NCP. Under the No Action alternative, no activities would be implemented to remove, treat, or contain sediment contaminants in the Removal Action Area, which would remain in its current condition.

7.3.2 Alternative A: MNR Emphasis

Alternative A consists of a combination of MNR and capping in Slip 1, Wheeler Bay, and Berth 401; MNR in the North of Berth 414 subarea; and a combination of dredging, capping, and MNR in Slip 3. Operationally, Pier 4 in Slip 3, the barge leg in Slip 1, Berth 408, and Berth 401 remain active. In Slip 1, demolition of warehouses at Berth 405 and demolition of pier decks and pier framework are assumed at Berths 405/408. Affected outfalls are modified (primarily by extending piping and reconstructing the outfall). Institutional controls will also be implemented, including identification of the capped areas as no commercial vessel anchoring zones on U.S. Coast Guard navigational maps. The capped areas would also be identified on Port maps/plans to ensure that the integrity of caps is not impacted in the event of potential construction projects in the future.

Detailed Description:

Slip 1 – Combination of Monitored Natural Recovery and Capping
The Removal Action in Slip 1 consists of MNR and capping. The warehouses at Berth 405 and pier decks and framework at Berths 405/408 are demolished. A new barge docking facility is installed to replace the Berth 408 pier and to keep the bulk liquid cargo facility operational.

Slip 3 – Combination of Dredging, Capping, and Monitored Natural Recovery
The Removal Action in Slip 3 consists of a combination of dredging, capping, and a relatively small area of MNR (i.e., the under-pier area at Berth 410 below the finger pier portion). The area at Pier 5 is capped, while the area between Pier 4 and Pier 5 is dredged. Dredging is performed in front of Pier 4 to remove contamination. Capping is impractical due to the need to maintain ship access to the actively used Berths 410 and 411. The nearshore slopes under Pier 4 at Berth 411 are capped. Dredging under this pier is impractical due to the presence of riprap. Some dredging, but primarily capping, is used in a relatively small slope area at the head of Slip 3 below the existing pinch pile bulkhead. Dredging in this area would decrease the stability of the slope. Barge-to-rail transloading of dredged sediments could potentially be performed using the rail spurs at Berths 410/411 (i.e., Kinder Morgan facility). Kinder Morgan's operations would be shut down during dredging in Slip 3.

Wheeler Bay – Monitored Natural Recovery and Capping
The depth of detected sediment contaminants found in Wheeler Bay varied, extending from the surface to beyond 22 feet below the sediment surface. Since contaminant concentrations identified in most of Wheeler Bay are low, MNR is used for the majority of Wheeler Bay. A portion of the slope is capped as shown on the figure because of higher PAH concentrations in one sample location.

North of Berth 414 – Monitored Natural Recovery
Similar to Wheeler Bay, low contaminant concentrations were found in the North of Berth 414 subarea up to 22 feet below the sediment surface. Therefore, MNR is used north of Berth 414.

Berth 401 – Monitored Natural Recovery and Capping
MNR is used for the majority of the area at Berth 401 because of low contaminant concentrations. A relatively small area in the northeast corner of the Berth 401 area is capped because of marginal PCB concentrations in one sample location.

Construction Sequence, Comments, and Assumptions
- Dredging in Slip 3 should be performed prior to capping in that area to avoid recontamination of slope areas.
- Kinder Morgan's operations would be disrupted during the duration of dredging in Slip 3.
- If rail transport is used to haul dredged material offsite, a transload facility would be established at Berth 409.
- Simultaneous dredging in Slip 3 and capping in other areas may be possible.
- Capping under the pier at Berth 411 may be performed during the year after dredging to reduce disruption to Kinder Morgan's operations.

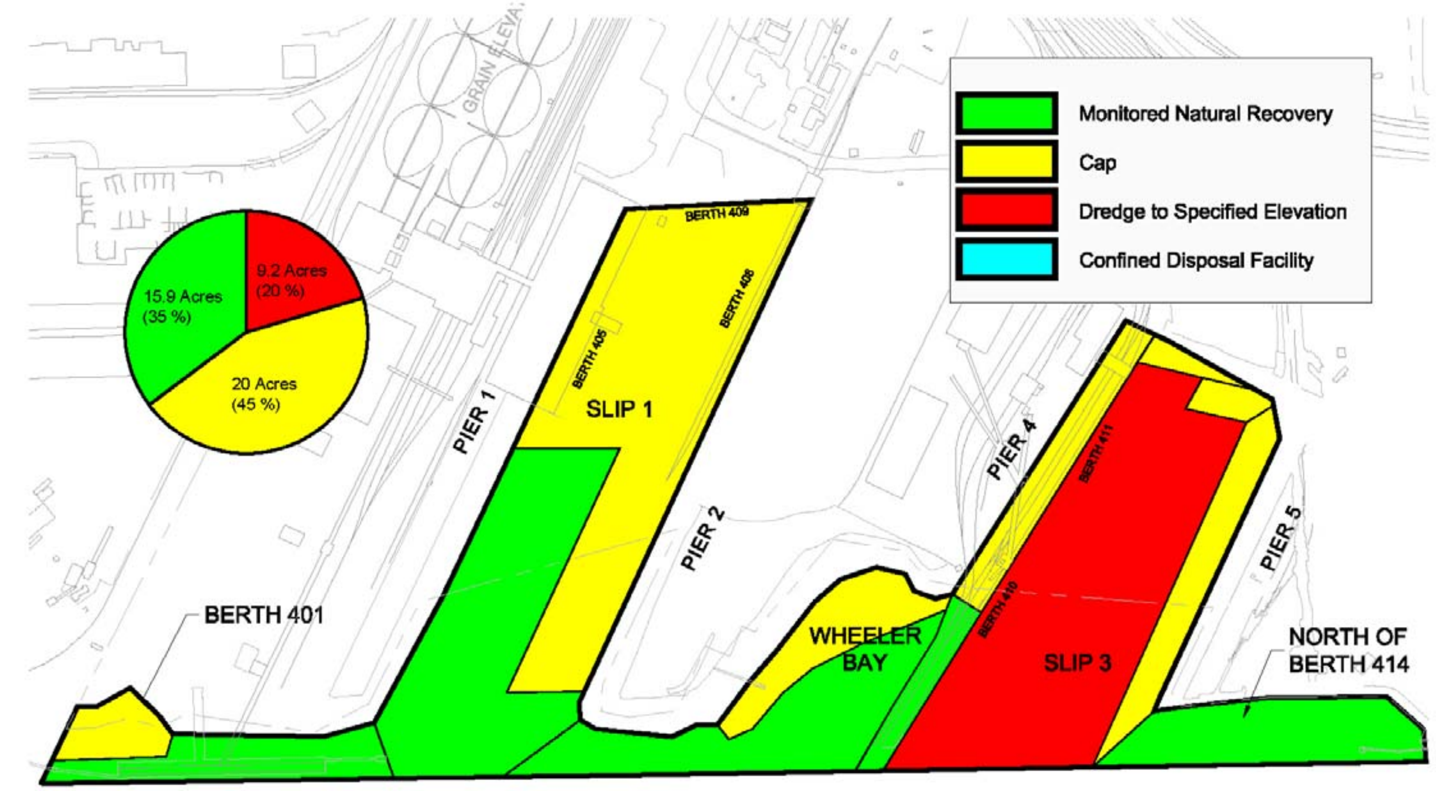
Assumed Schedule
- Year 1: Dredging in Slip 3 and capping in areas outside of Slip 3; miscellaneous other work such as demolition of piers would occur prior to capping in Slip 1.
- Year 2: Capping in Slip 3.

Cost
Net Present Value (2005) = $23,303,000

IMPORTANT QUANTITIES

Item	Units	Quantity					
		Slip 1	Slip 3	Wheeler Bay	North of Berth 414	Berth 401	Total
Dredging Area	Acres		9.2				9.2
Dredging Volume	CY		105,000				105,000
Under-Pier Capping Area	Acres		1.7				1.7
Non-Under-Pier Capping Area	Acres	11.3	2.8	3.0		1.2	18.3
Total Capping Area	Acres	11.3	4.5	3.0		1.2	20.0
Capping Volume	CY	54,500	22,000	14,500		5,500	96,500
MNR Area	Acres	5.9	0.7	4.0	3.0	2.3	15.9
CDF Capacity	CY						N/A
CDF Cap Volume	CY						N/A
CDF Berm Volume	CY						N/A

Notes:
cubic yard (CY)
Dredge volumes do not include sediment bulking



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its federal, state and tribal partners, and is subject to change in whole or in part.

7.3.3 Alternative B: Cap Emphasis

Alternative B is similar to Alternative A, but has a greater reliance on capping in Slip 1. Alternative B consists of a combination of capping in Slip 1 and MNR at the mouth of Slip 1; a combination of capping and MNR in Wheeler Bay and Berth 401; MNR in the North of Berth 414 subarea; and a combination of dredging, capping, and MNR in Slip 3. Operationally, Pier 4 in Slip 3, the barge leg in Slip 1, Berth 408, and Berth 401 remain active. In Slip 1, demolition of warehouses at Berth 405 and demolition of pier decks and framework are assumed at Berths 405/408. Affected outfalls are modified (primarily by extending piping and reconstructing the outfall). Institutional controls will be implemented for the capped areas, including identification of the capped areas as no commercial vessel anchoring zones on U.S. Coast Guard navigational maps and identification on Port maps/plans to ensure that the integrity of caps is not impacted in the event of potential construction projects in the future.

Detailed Description:

Slip 1 – Combination of Monitored Natural Capping and Recovery

The Removal Action in Slip 1 consists of capping, with a small area of MNR at the mouth of the slip. The warehouses at Berth 405 and pier decks and framework at Berths 405/408. A new barge docking facility is installed to replace the Berth 408 pier and to keep the bulk liquid cargo facility operational.

Slip 3 – Combination of Dredging, Capping, and Monitored Natural Recovery

The Removal Action in Slip 3 consists of a combination of dredging, capping, and a relatively small area of MNR (i.e., the under-pier area at Berth 410 below the finger pier portion). The area at Pier 5 is capped, while the area between Pier 4 and Pier 5 is dredged. Dredging is performed in front of Pier 4 to remove contamination. Capping is impractical due to the need to maintain ship access to the actively used Berths 410 and 411. The nearshore slopes under Pier 4 at Berth 411 are capped. Dredging under this pier is impractical due to the presence of riprap. Some dredging, but primarily capping, is used in a relatively small slope area at the head of Slip 3 below the existing pinch pile bulkhead. Dredging in this area would decrease the stability of the slope. Barge-to-rail transloading of dredged sediments could potentially be performed using the rail spurs at Berths 410/411 (i.e., Kinder Morgan facility). Kinder Morgan's operations would be shut down during dredging in Slip 3.

Wheeler Bay – Monitored Natural Recovery and Capping

The depth of detected sediment contaminants found in Wheeler Bay varied, extending from the surface to beyond 22 feet below the sediment surface. The vibracore and piston core explorations did not encounter the bottom of detected contaminants in some areas. Since contaminant concentrations identified in most of Wheeler Bay are low, MNR is used for the majority of Wheeler Bay. A portion of the slope is capped as shown on the figure because of higher PAH concentrations in one sample location.

North of Berth 414 – Monitored Natural Recovery

Similar to Wheeler Bay, low contaminant concentrations were found in the North of Berth 414 subarea up to 22 feet below the sediment surface. Therefore, MNR is used north of Berth 414.

Berth 401 – Monitored Natural Recovery and Capping

MNR is used for the majority of the area at Berth 401 because of low contaminant concentrations. A relatively small area in the northeast corner of the Berth 401 area is capped because of marginal PCB concentrations in one sample location.

Construction Sequence, Comments, and Assumptions

- Dredging in Slip 3 should be performed prior to capping in that area to avoid recontamination of slope areas.
- Kinder Morgan's operations would be disrupted during the duration of dredging in Slip 3.
- If rail transport is used to haul dredged material offsite, a transload facility would be established at Berth 409.
- Simultaneous dredging in Slip 3 and capping in other areas may be possible.
- Capping under the pier at Berth 411 may be performed during the year after dredging to reduce disruption to Kinder Morgan's operations.

Assumed Schedule

- Year 1: Dredging in Slip 3 and capping in areas outside of Slip 3; miscellaneous other work such as demolition of piers would occur prior to capping in Slip 1.
- Year 2: Capping in Slip 3.

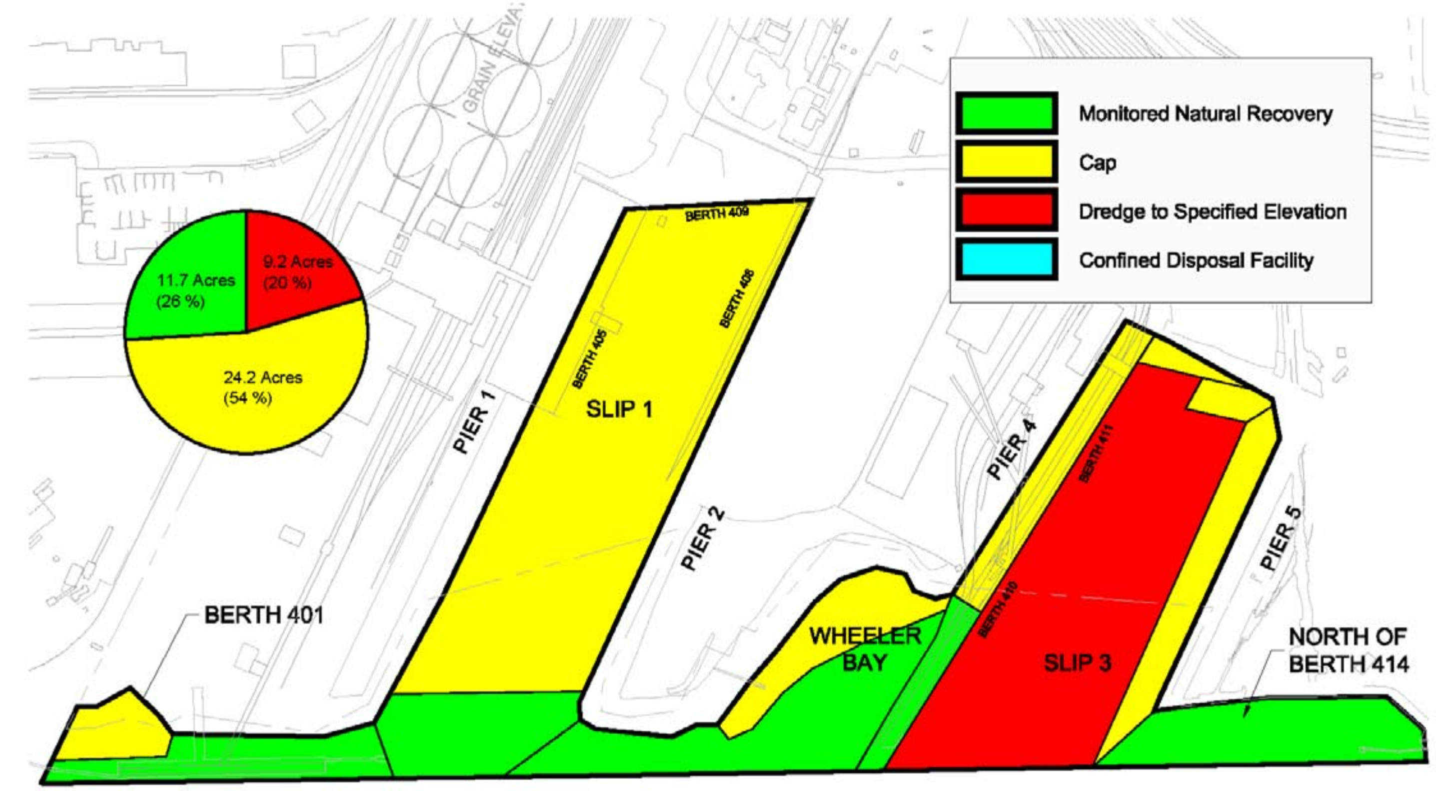
Cost

Net Present Value (2005) = $24,627,000

IMPORTANT QUANTITIES

Item	Units	Quantity					
		Slip 1	Slip 3	Wheeler Bay	North of Berth 414	Berth 401	Total
Dredging Area	Acres		9.2				9.2
Dredging Volume	CY		105,000				105,000
Under-Pier Capping Area	Acres		1.7				1.7
Non-Under-Pier Capping Area	Acres	15.5	2.8	3.0		1.2	22.5
Total Capping Area	Acres	15.5	4.5	3.0		1.2	24.2
Capping Volume	CY	75,000	22,000	14,500		5,500	117,000
MNR Area	Acres	1.7	0.7	4.0	3.0	2.3	11.7
CDF Capacity	CY						N/A
CDF Cap Volume	CY						N/A
CDF Berm Volume	CY						N/A

Notes:
cubic yard (CY)
Dredge volumes do not include sediment bulking



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its federal, state and tribal partners, and is subject to change in whole or in part.

7.3.4 Alternative C: Dredge Emphasis with CDF Disposal – At-Grade Full-Size CDF

Alternative C consists of construction of an at-grade CDF that occupies the entire Slip 1; a combination of dredging, capping, and MNR in Slip 3; a combination of MNR and capping in Wheeler Bay and Berth 401; and MNR in the North of Berth 414 subarea. Operationally, Pier 4 in Slip 3 and Berth 401 remain active. The grain facility barge leg and the International Raw Materials barge operations in Slip 1 are relocated, as demolition of warehouses and piers is assumed, including pulling/breaking timber piles and providing upland disposal of timber piling and construction debris. Outfalls are completely relocated and rerouted. Former storm sewer piping discharge to Slip 1 is abandoned under this alternative. Institutional controls for capped areas would include anchoring restrictions for commercial vessels and updating Port engineering maps/plans identifying the capped areas for any planned construction projects or changes in operations to ensure the integrity of the cap is not disturbed or compromised. Institutional controls for the CDF would include updating engineering baseline maps/plans to include the CDF boundaries, update provisions in tenant leases, as applicable, formalizing notification procedures for construction or change in operations in the area of the CDF. Deed notifications or easements may also be considered.

Detailed Description:

Slip 1 – Full At-Grade Confined Disposal Facility (CDF)

Sediment dredged in Slip 3 is disposed of in the Slip 1 CDF. An at-grade CDF that occupies the entire Slip 1 has excess capacity available for other dredged sediment. By constructing the CDF to an at-grade surface, the newly gained land can be used for water-dependent purposes consistent with existing zoning and Port use. An earthen containment berm is constructed at the mouth of Slip 1 to serve as an isolation/retaining structure for the dredged sediment. The area under the containment berm is dredged. The berm is placed on State-owned property. Use of State property requires negotiation.

Slip 3 – Combination of Dredging, Capping, and Monitored Natural Recovery

The Removal Action in Slip 3 consists of a combination of dredging, capping, and a relatively small area of MNR (i.e., the under-pier area at Berth 410 below the finger pier portion). The area at Pier 5 is capped, while the area between Pier 4 and Pier 5 is dredged. Dredging is performed in front of Pier 4 to remove contamination. Capping is impractical due to the need to maintain ship access to the actively used Berths 410 and 411. The nearshore slopes under Pier 4 at Berth 411 are capped. Dredging under this pier is impractical due to the presence of riprap. Some dredging, but primarily capping, is used at a relatively small slope area at the head of Slip 3 below the existing pinch pile bulkhead. Dredging in this area would decrease the stability of the slope.

Wheeler Bay – Monitored Natural Recovery and Capping

The depth of detected sediment contamination in Wheeler Bay varied, extending from the surface to beyond 22 feet below the sediment surface. Since contaminant concentrations identified in most of Wheeler Bay are low, MNR is used for the majority of Wheeler Bay. A portion of the slope is capped as shown on the figure because of higher PAH concentrations in one sample location.

North of Berth 414 – Monitored Natural Recovery

Similar to Wheeler Bay, low contaminant concentrations were found in the North of Berth 414 subarea up to 22 feet below the sediment surface. Therefore, MNR is used north of Berth 414.

Berth 401 – Monitored Natural Recovery and Capping

MNR is used for the majority of the area at Berth 401 because of low contaminant concentrations. A relatively small area in the northeast corner of the Berth 401 area would be capped because of marginal PCB concentrations in one sample location.

Construction Sequence, Comments, and Assumptions:

- It is assumed that approximately 10,000 cy of sediments would be dredged in Slip 1, in the area of the footprint of the CDF containment berm, to remove contaminated sediments and to provide a firm foundation for the berm.
- The sediments dredged in Slip 1 would be placed near the head of the slip. Placement should be performed with care to minimize sediment resuspension.
- The CDF containment berm would be constructed prior to dredging in Slip 3. The berm may be constructed in stages to allow barge access for disposal of Slip 3 sediments. If sediments are transported to the CDF in pipelines, it is assumed that the entire berm would be constructed prior to dredging. The berm material volume is fairly large and berm construction may take longer than one construction season.
- Dredging in Slip 3 should be performed prior to capping in that area to avoid recontamination of slope areas.
- Kinder Morgan's operations would be disrupted during the duration of dredging in Slip 3.
- An intermediate CDF cap may be required at the conclusion of Slip 3 dredging unless the period between disposal events is relatively short.
- Capping under the pier at Berth 411 may be performed during the year after dredging to minimize disruption of Kinder Morgan's operations.
- Simultaneous berm construction and capping in Wheeler Bay and at Berth 401 should be possible.

Assumed Schedule:

For barge transport:

- Year 1: Stage 1 berm construction and simultaneous capping in Wheeler Bay and at Berth 401. Miscellaneous other work such as demolition of piers and warehouses.
- Year 2: Dredging in Slip 3. Possibly placement of intermediate CDF cap.
- Year 3: Stage 2 berm construction and capping in Slip 3.

For pipeline transport:

- Year 1: Stage 1 berm construction and simultaneous capping in Wheeler Bay and at Berth 401. Miscellaneous other work such as demolition of piers.
- Year 2: Stage 2 berm construction, dredging in Slip 3 following completion of berm, and possibly placement of intermediate CDF cap.
- Year 3: Capping in Slip 3.

Filling of the CDF will continue after construction year 3.

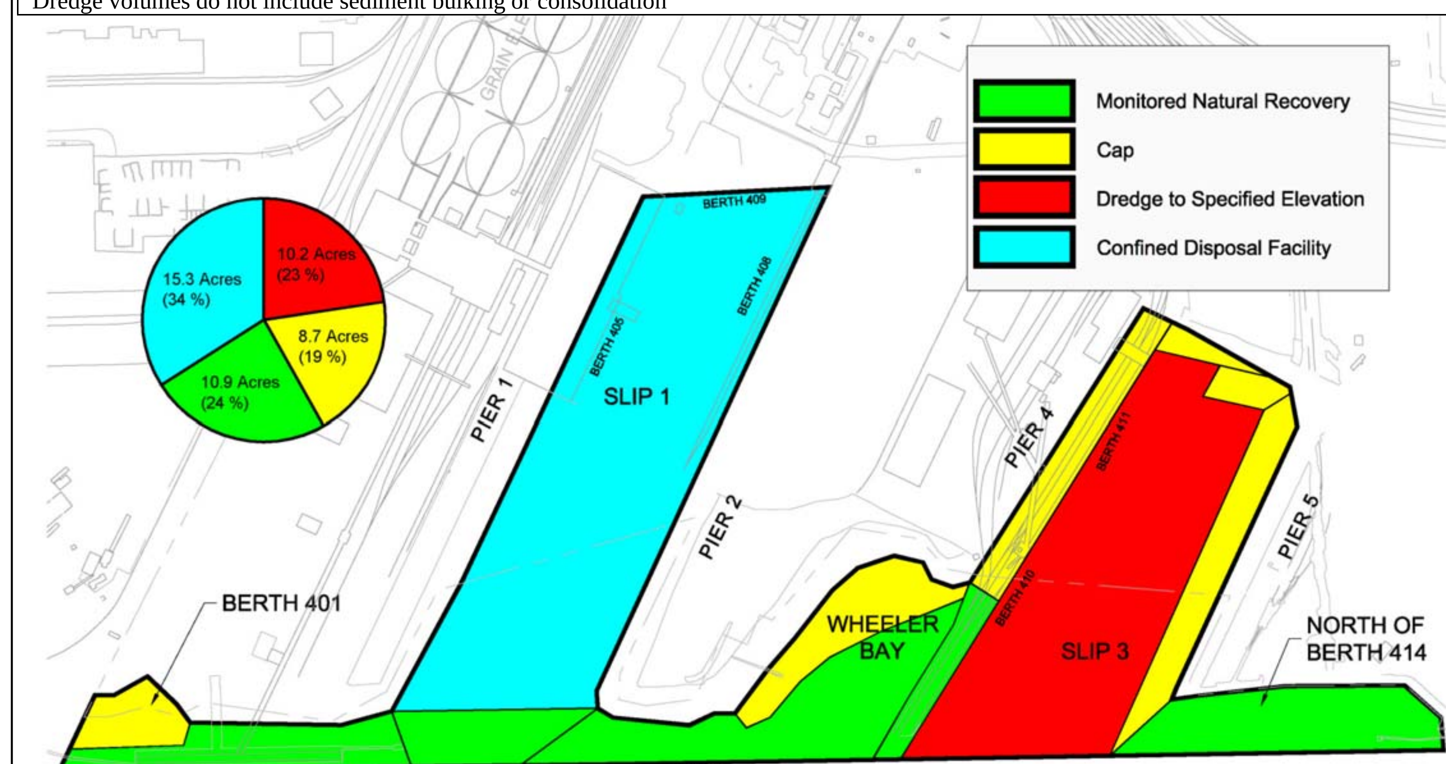
Cost

Net Present Value (2005) = $30,555,000 ($20,555,000 including value of excess capacity)

IMPORTANT QUANTITIES

Item	Units	Quantity					
		Slip 1	Slip 3	Wheeler Bay	North of Berth 414	Berth 401	Total
Dredging Area	Acres	1.0	9.2				10.2
Dredging Volume	CY	10,000	105,000				115,000
Interim Cap (if needed)	CY						20,000
Under-Pier Capping Area	Acres		1.7				1.7
Non-Under-Pier Capping Area	Acres		2.8	3.0		1.2	7.0
Total Capping Area	Acres		4.5	3.0		1.2	8.7
Capping Volume	CY		22,000	14,500		5,500	42,000
MNR Area	Acres	0.9	0.7	4.0	3.0	2.3	10.9
Total Capacity of the CDF	CY						940,000
CDF Excess Capacity – Saturated (dredged sediments)	CY						560,000
Unsaturated Zone Capacity (Fill)	CY						245,000
Volume of CDF Engineering Cap	CY						255,000
CDF Berm Volume	CY						138,500

Notes:
cubic yard (CY)
For this calculation, a 10-foot-thick CDF cap was assumed. The top of CDF cap/berm was assumed to be at approx. elevation 31.5 ft. Columbia River Datum (CRD)
Dredge volumes do not include sediment bulking or consolidation



7.3.5 Alternative D: Dredge Emphasis with Landfill Disposal

Alternative D consists of a combination of dredging, capping, and MNR in Slip 3; MNR and capping in Berth 401 and Wheeler Bay; and MNR in the North of Berth 414 subarea. Slip 1 would be dredged. Operationally, Pier 4 in Slip 3, the barge leg in Slip 1, and Berth 401 remain active. To facilitate dredging, demolition of warehouses and piers that are not required to sustain barge docking operations is assumed. Removal of timber piles is accomplished by pulling the piles and disposing of them at an appropriate upland disposal facility. Outfalls are modified as needed to facilitate dredging. Institutional controls will be implemented for the capped areas, including identification of the capped areas as no commercial vessel anchoring zones on U.S. Coast Guard navigational maps and identification on Port maps/plans to ensure that the integrity of caps is not impacted in the event of potential construction projects in the future.

Detailed Description:

Slip 1 – Dredging and Monitored Natural Recovery
The Removal Action in Slip 1 consists of dredging except at the mouth of the slip, where the Removal Action consists of MNR. Dredging requires demolition of warehouses and pier structures in Slip 1, including removal of piles. A new barge docking facility is installed to replace the Berth 408 pier and to keep the bulk cargo facility operational.

Slip 3 – Combination of Dredging, Capping, and Monitored Natural Recovery
The Removal Action in Slip 3 consists of a combination of dredging, capping, and a relatively small area of MNR (i.e., the under-pier area at Berth 410 below the finger pier portion). The area at Pier 5 is capped, while the area between Pier 4 and Pier 5 is dredged. Dredging is performed in front of Pier 4 to remove contamination. Capping is impractical due to the need to maintain ship access to the actively used Berths 410 and 411. The nearshore slopes under Pier 4 at Berth 411 are capped. Dredging under this pier is impractical due to the presence of riprap. Some dredging, but primarily capping, is used in a relatively small slope area at the head of Slip 3 below the existing pinch pile bulkhead. Dredging in this area would decrease the stability of the slope. Barge-to-rail transloading of dredged sediments could potentially be performed using the rail spurs at Berths 410/411 (i.e., Kinder Morgan facility). Kinder Morgan's operations would be shut down during dredging in Slip 3.

Wheeler Bay – Monitored Natural Recovery and Capping
The depth of detected sediment contaminants found in Wheeler Bay varied, extending from the surface to beyond 22 feet below the sediment surface. Since contaminant concentrations identified in most of Wheeler Bay are low, MNR is used for the majority of Wheeler Bay. A portion of the slope is capped as shown on the figure because of higher PAH concentrations in one sample location.

North of Berth 414 – Monitored Natural Recovery
Similar to Wheeler Bay, low contaminant concentrations were found in the North of Berth 414 subarea up to 22 feet below the sediment surface. Therefore, MNR is used north of Berth 414.

Berth 401 – Monitored Natural Recovery and Capping
MNR is used for the majority of the area at Berth 401 because of low contaminant concentrations. A relatively small area in the northeast corner of the Berth 401 area is capped because of marginal PCB concentrations in one sample exploration.

Construction Sequence, Comments, and Assumptions:

- Dredging in Slip 3 should be performed prior to capping in that area to avoid recontamination of slope areas.
- Dredging could possibly be performed simultaneously in Slip 1 and Slip 3. Several transport technologies may have to be employed to meet transport capacity requirement for simultaneous dredging.
- Kinder Morgan's operations would be disrupted during the duration of dredging in Slip 3.
- If rail transport is used to haul dredged material offsite, a transload facility would be established at Berth 409.
- Simultaneous dredging and capping in Wheeler Bay and at Berth 401 is generally possible, but could be affected if a second transload facility is needed.
- Capping under the pier at Berth 411 may be performed during the year after dredging to minimize disruption of Kinder Morgan's operations.

Assumed Schedule:

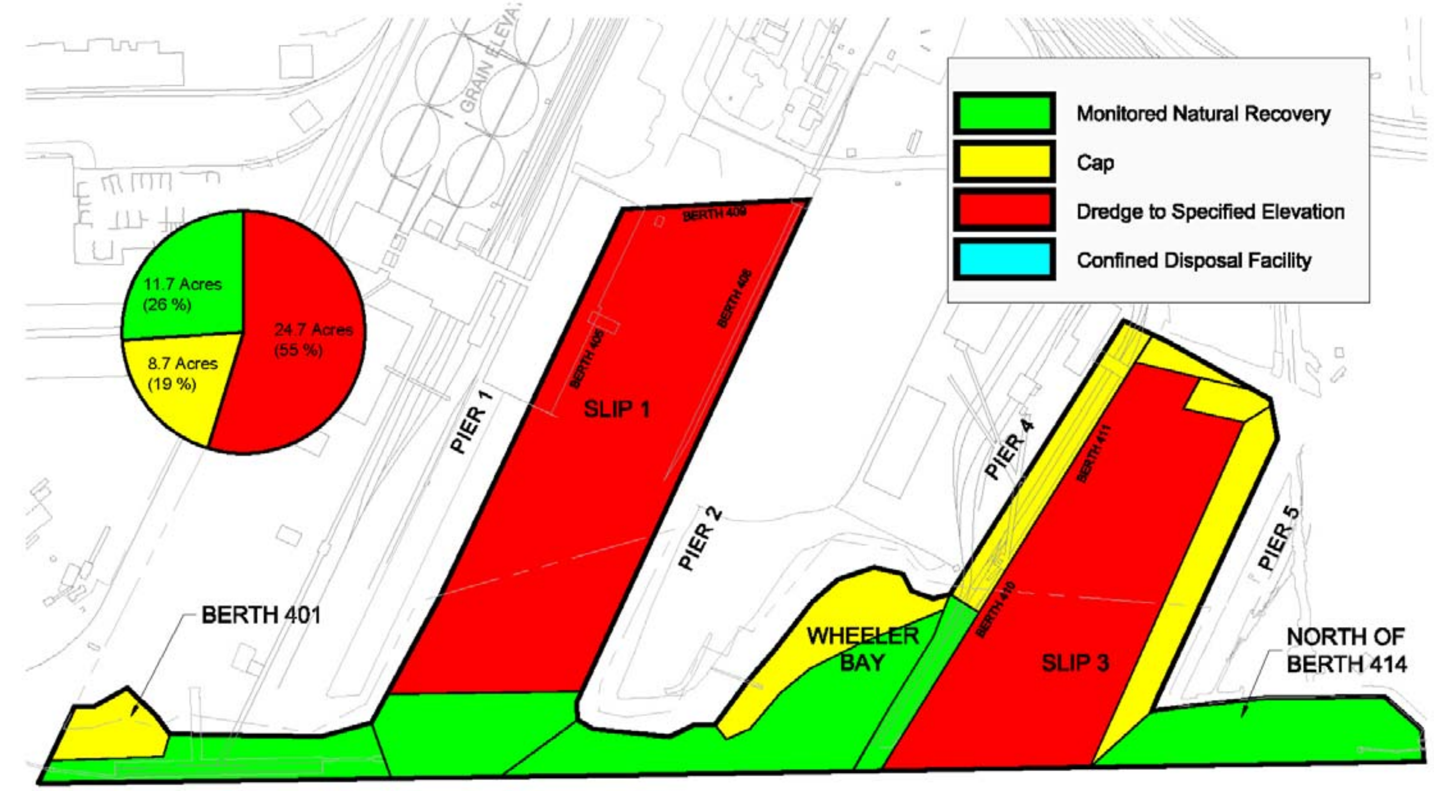
- Year 1: Dredging in Slip 1, dredging in Slip 3; miscellaneous other work such as demolition of piers would occur prior to capping in Slip 1.
- Year 2: Capping in Slip 3 and capping in Wheeler Bay and at Berth 401.

Cost
Net Present Value (2005) = $26,431,000

IMPORTANT QUANTITIES

Item	Units	Quantity					
		Slip 1	Slip 3	Wheeler Bay	North of Berth 414	Berth 401	Total
Dredging Area	Acres	15.5	9.2				24.7
Dredging Volume	CY	99,000	105,000				204,000
Under-Pier Capping Area	Acres		1.7				1.7
Non-Under-Pier Capping Area	Acres		2.8	3.0		1.2	7.0
Total Capping Area	Acres		4.5	3.0		1.2	8.7
Capping Volume	CY		22,000	14,500		5,500	42,000
MNR Area	Acres	1.7	0.7	4.0	3.0	2.3	11.7
CDF Capacity	CY						N/A
CDF Cap Volume	CY						N/A
CDF Berm Volume	CY						N/A

Notes:
cubic yard (CY)
Dredge volumes do not include sediment bulking



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This document is currently under review by US EPA and
its federal, state and tribal partners, and is subject to change in whole or in part.

7.4 Public and Stakeholder Involvement

In July 2004, the Port initiated public outreach regarding the development of the Removal Action alternatives. The outreach was a voluntary effort consistent with a strategic objective that spans all of the Port's programs: to enhance the Port's effectiveness by strengthening stakeholder involvement and communications and to integrate stakeholder input into planning and decision making.

7.4.1 Community Outreach

The Port met with the community groups listed below and hosted two open houses to maximize the community's opportunity to obtain information about the project and provide the Port with feedback. In all, the Port has participated in and/or hosted 21 meetings and events attended by more than 275 people. An effort has been made to meet with the groups more than once to provide updated project information. The Port anticipates continuing outreach to the community as the project proceeds in 2005.

Neighborhood Associations and Residential Community

- July 12, 2004 – St. Johns Neighborhood Association General Meeting
- July 13, 2004 – Friends of Cathedral Park Neighborhood Association General Meeting
- July 20, 2004 – Overlook Park Neighborhood Association General Meeting
- August 23, 2004 – University Park Neighborhood Association General Meeting
- September 1, 2004 – Linnton Neighborhood Association General Meeting
- November 9, 2004 – Friends of Cathedral Park Neighborhood Association General Meeting
- November 22, 2004 – University Park Neighborhood Association General Meeting
- November 29, 2004 – St. Johns Neighborhood Association Board Meeting
- January 13, 2005 – Harvest Homes residents, staff and neighbors
- March 2, 2005 – Linnton Neighborhood Association General Meeting
- March 16, 2005 – Overlook Neighborhood Association General Meeting

Environmental Groups

- September 30, 2004 – Travis Williams, Willamette Riverkeeper
- October 19, 2004 – Jill Fuglister, The Coalition for a Livable Future
- November 30, 2004 – Meryl Redisch and Bob Sallinger, Audubon Society of Portland

Community Groups

- July 16, 2004 – Portland Harbor Community Advisory Group (CAG), Evaluation Committee
- December 10, 2004 – CAG, Evaluation Committee
- April 13, 2005 – CAG Meeting – Portland Harbor Early Action Update by EPA Project Manager Sean Sheldrake. Port staff was available to respond to questions but did not make a formal presentation.

Willamette River Community Events

- September 18, 2004 – Portland Harbor Field Day, organized by public agencies and the Lower Willamette Group
- October 2, 2004 – Portland Paddle, organized by Willamette Riverkeeper

Project Open Houses

- December 2, 2004 – Port of Portland Building
- December 11, 2004 – St. Johns Community Center

7.4.2 Elected Officials and Staff

In conjunction with participating in community meetings and events, Port staff met with local and regional elected officials and their staff to provide them with information and listen to their feedback. This included meetings with Portland's mayor and mayoral staff, city commissioners and their staff, Multnomah County commissioners and their staff, and Metro councilors and their staff.

The Port anticipates continued outreach to these officials in 2005.

7.4.3 Agency and Tribal Involvement

To keep state and federal agencies, tribal nations, and other interested parties informed about the project status and obtain input on the development of the Removal Action alternatives, Port staff hold monthly meetings on the third Thursday of each month. Every third meeting (referred to as the quarterly meeting) takes place in Portland and is focused on the overall project status. In 2005, the quarterly meetings will take place in February, May, August, and November. The remaining monthly meetings are held in Seattle and are focused on month-to-month activities. In addition, the Port maintains a website for sharing information and deliverables with the interested parties. The following entities are invited to participate in the meetings:

Tribal Nations

Confederated Tribes of the Siletz Indians of Oregon Confederated Tribes
Confederated Tribes of the Grand Ronde Community of Oregon
Confederated Tribes of the Umatilla Indian Reservation
Confederated Tribes of the Warm Springs Reservation of Oregon
Nez Perce Tribe
Bands of theYakama Nation

State Agencies

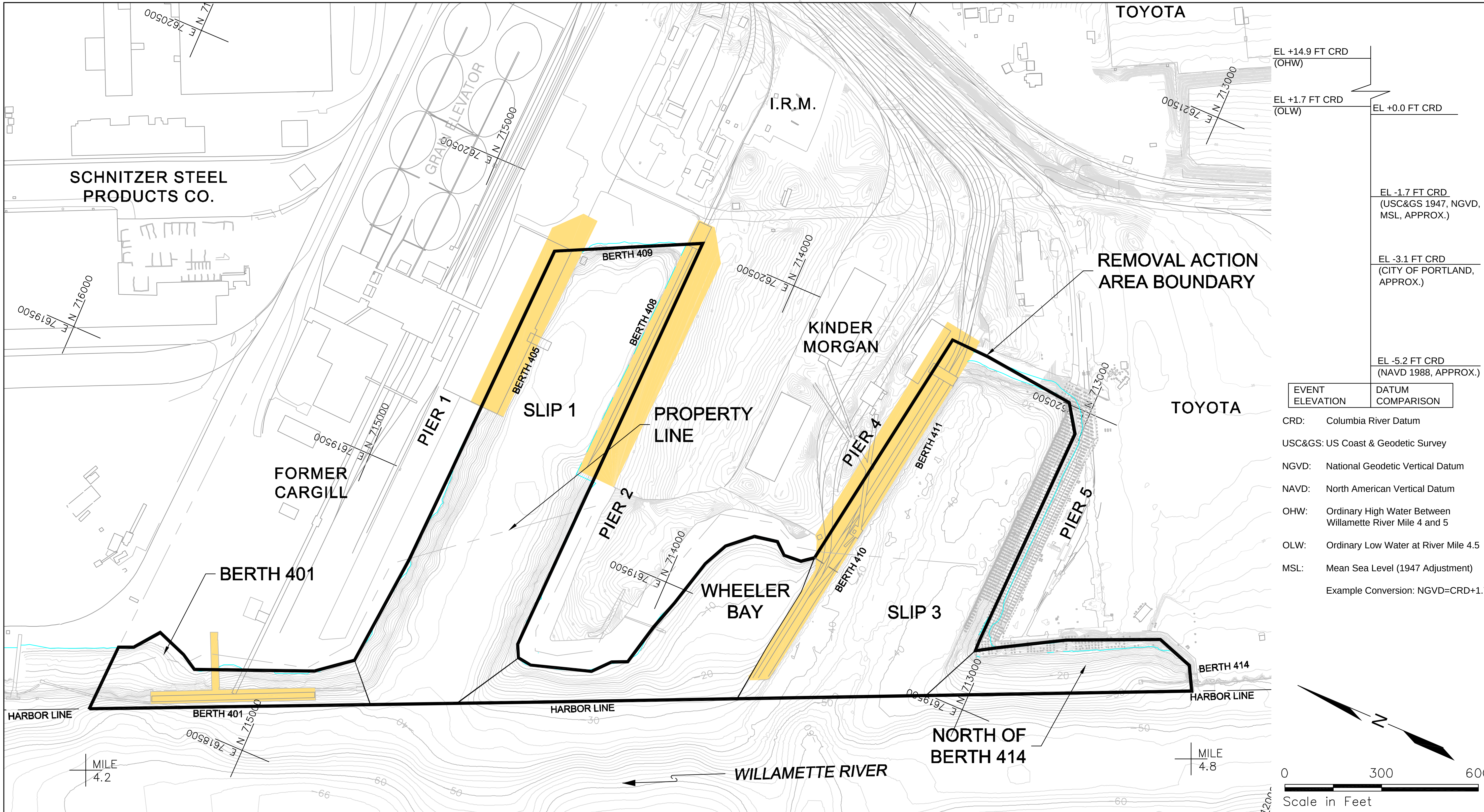
Oregon Department of Environmental Quality
Oregon Department of Fish and Wildlife
Oregon Department of State Lands

Federal Agencies

U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
NOAA Fisheries

Other Interested Parties

City of Portland
UPRR



Notes:

1. Upland topographic vertical datum is NGVD; Bathymetric vertical datum is CRD.
2. Site Plan is based on drawings provided by the Port of Portland.
3. Shoreline boundary for Ordinary High Water is approximate.
4. Willamette River Mile reference marks are approximate.
5. Diurnal tide range during low river stages is 2.2 feet at St. Johns and 2.4 feet at Portland.
6. Datum conversion tables to CRD provided by Port of Portland.
7. Ordinary Low Water elevation provided by USACE.
8. Ordinary High Water elevation provided by Port of Portland.
9. Datum conversion tables to CRD provided by Port of Portland.

Existing Piers

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PORT OF PORTLAND
PORTLAND, OREGON
TERMINAL 4 EARLY ACTION
EE/CA REPORT

SUBAREAS WITHIN THE TERMINAL 4 REMOVAL ACTION AREA

BBL
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

FIGURE
7-1

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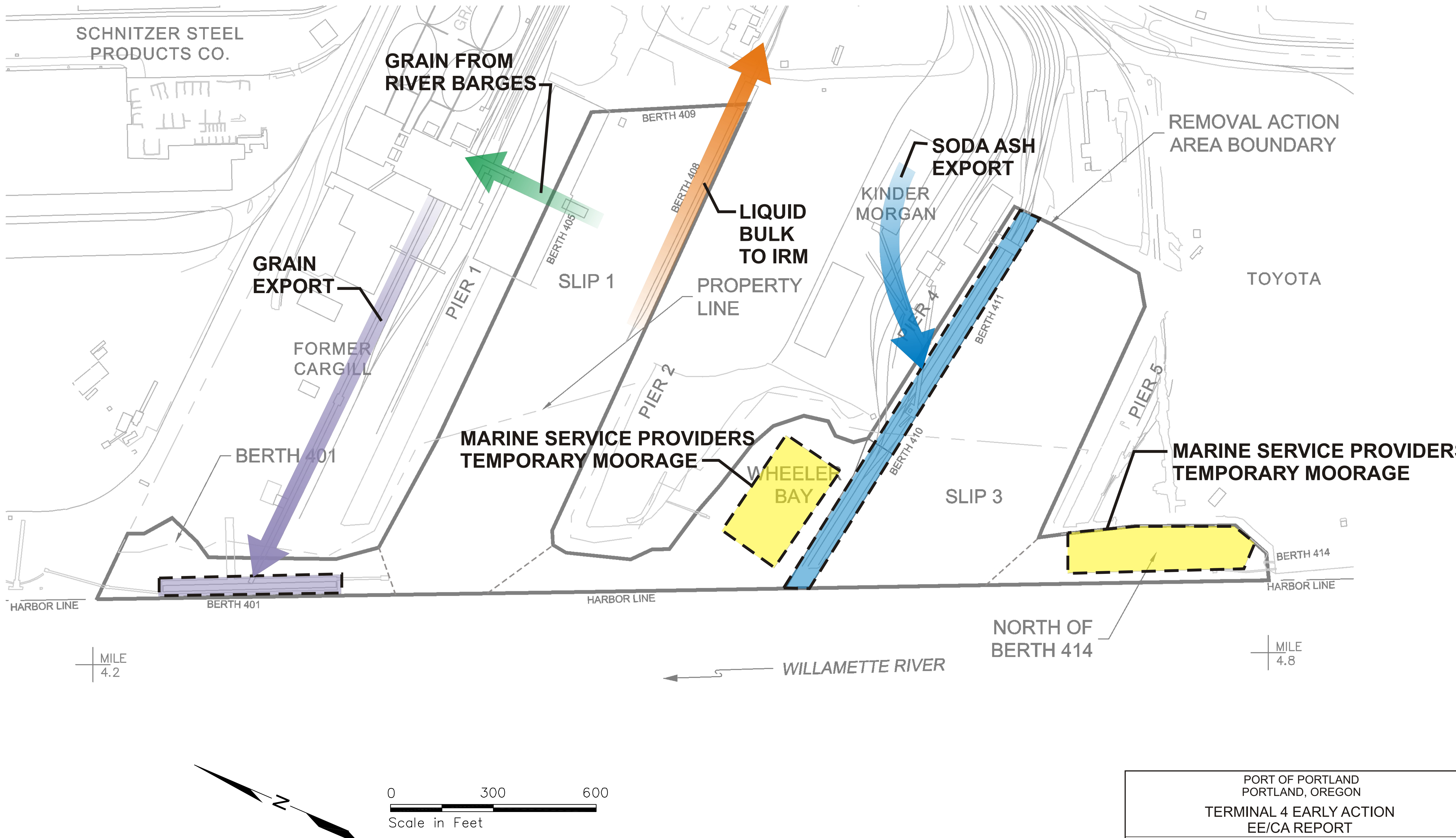

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This document is currently under review by US EPA and its federal, state and tribal partners, and is subject to change in whole or in part.

PORT OF PORTLAND
PORTLAND, OREGON

TERMINAL 4 EARLY ACTION
EE/CA REPORT

TERMINAL 4 FLOW OF CARGO

BBL
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

FIGURE
7-2

8. Evaluation of Removal Action Alternatives

This section evaluates the Removal Action alternatives, both individually and comparatively, with respect to the CERCLA non-time critical removal action (NTCRA) evaluation criteria. The evaluation criteria fall into three categories: threshold criteria, balancing criteria, and modifying criteria (USEPA, 1988). An alternative must meet the threshold criteria (overall protection of human health and the environmental and compliance with ARARs) before it can be considered as the Preferred Alternative for a site. All of the alternatives evaluated below meet the threshold criteria except for the No Action alternative, which has been included solely to provide a baseline against which to evaluate the other alternatives. The balancing criteria, which are the focus of the EE/CA, are effectiveness, implementability, and cost. The modifying criteria, state and community acceptance, are evaluated by USEPA after the public comment period.

Among the three balancing criteria of effectiveness, implementability, and cost, there are subcriteria for effectiveness and implementability.

The subcriteria for effectiveness are:

- overall protection of human health and the environment;
- compliance with ARARs and other criteria, advisories, and guidance;
- short-term effectiveness;
- reduction of mobility, volume, and toxicity of contaminants through treatment; and
- long-term effectiveness and permanence.

The evaluation of the first two subcriteria considers how well the alternative will protect human health and the environment and comply with ARARs and other criteria, as well as draws on the assessments conducted for the other effectiveness subcriteria. Short-term effectiveness evaluates the effect of implementing the Removal Action on the community, workers, and the environment. Long-term effectiveness evaluates the magnitude of risk and the adequacy/reliability of controls to ensure the long-term effectiveness. According to NTCRA guidance, “if the non-time critical removal action is an interim step and is expected to be followed by remedial action, this factor could be reduced in scope or deleted, if appropriate.” The RAOs for this Removal Action include reducing ecological and human health risk associated with sediment contamination to acceptable levels. The USEPA is currently evaluating sediment contamination within the Portland Harbor Superfund Site and will be developing risk criteria and sediment cleanup goals for Portland Harbor based on these evaluations. Therefore, the Removal Action is an interim step until the acceptable levels have been defined and the results of this Removal Action can be compared to those levels. If sediment concentrations in portions or all of the Removal Action Area do not meet the acceptable levels, further removal action may be required. Therefore, the scope of evaluating the long-term effectiveness was reduced in accordance with the NTCRA guidance and focuses on the adequacy and reliability of controls.

The subcriteria for implementability are:

- technical feasibility;
- administrative feasibility;
- availability of services and materials;
- state (supporting agency) acceptance; and
- community acceptance.

The last two evaluation subcriteria for implementability are considered modifying criteria under CERCLA. Modifying criteria are addressed by the USEPA following submittal of the public review draft EE/CA and subsequent public comment period and are therefore not evaluated in the EE/CA.

Sections 8.1 through 8.5 provide the evaluations of each individual Removal Action alternative against the NTCRA evaluation criteria. Section 8.6 presents the comparative evaluation of the Removal Action alternatives against each other to evaluate their relative performance in relation to the evaluation criteria.

8.1 No Action Alternative

The No Action alternative, as described in Section 7.3.1, would not involve any activities to remove, treat, or contain the contaminants in the sediment. The No Action alternative is not protective of human health and the environment, and RAOs would not be achieved. Because this alternative does not meet the threshold criterion of achieving RAOs – one of which is to reduce ecological and human health risks associated with sediment contamination within the Removal Action Area to acceptable levels – it is not further considered.

8.2 Evaluation of Alternative A: MNR Emphasis

8.2.1 Effectiveness

This criterion addresses the ability of the alternative to meet the objective within the scope of the Removal Action.

8.2.1.1 Overall Protection of Public Health and the Environment

Alternative A meets the RAOs of reducing ecological and human health risks and the likelihood of recontamination. This alternative is expected to achieve the RAOs through a number of means, including dredging and capping areas where the highest levels of detected contaminants are found and by applying MNR in portions of the Removal Action Area where COPC concentrations are low.

Capping and dredging would prevent human and ecological receptors from contacting COPCs in the dredged or capped sediments by reducing the volume of sediments with detectable contamination in areas where dredging is proposed and by eliminating the exposure pathway and reducing the mobility of contaminants in areas where capping is proposed.

Under Alternative A, a larger portion of the Removal Action Area will be addressed through MNR as compared to the other three alternatives. MNR consists of complex physical, chemical, and biological processes, all leading to reductions in the volume and mobility of contaminants. The MNR areas have lower levels of COPCs in sediments than the capping and dredging areas and contribute only minimally to the risk of adverse effects on human health and the environment. COPCs are found at detectable levels in sediments of the MNR areas, but active removal or capping in these areas is not expected to significantly reduce risk. In addition, these areas are the most vulnerable to recontamination from upstream sources of COPCs. Based on modeling presented in Appendix H, MNR processes are expected to provide a long-term and permanent reduction in ecological and human health risk, thus providing adequate protection against those risks. The MNR areas will be monitored and, if after 5 years of post-removal action monitoring, concentrations are not consistent with RAOs, additional removal action will be evaluated. Consistency with RAOs will be based, in part, on risk-based criteria and/or cleanup goals established by USEPA through the harbor-wide RI/FS process for the Portland Harbor Superfund Site.

With respect to the other effectiveness subcriteria, Alternative A can be designed and implemented to meet the substantive requirements of the ARARs. The alternative is expected to exhibit relatively high short-term efficiency, since MNR poses negligible risk to the community, site workers, and the environment. Other technology components of the alternative are expected to exhibit less short-term efficiency, because they involve more site activities; however, the duration of these risks is short, and no unacceptable short-term impact is foreseen.

The overall protectiveness of the alternative will be further enhanced by institutional controls for areas that are capped. Proposed controls include identification of the capped areas as no commercial vessel anchoring zones. These areas would be identified on U.S. Coast Guard navigational maps. In addition, the capped areas would be identified on Port maps/plans to ensure that the integrity is not impacted during future potential construction.

8.2.1.2 Compliance with ARARs

Compliance with ARARs addresses whether a Removal Action alternative will meet the applicable and appropriate federal and state environmental requirements or whether grounds exist for a waiver. ARARs applicable to Alternative A are presented in Table 8-1.

Action-specific ARARs for Alternative A include ARARs for MNR, capping, and dredging. Chemical-specific ARARs will be addressed through implementation of the Removal Action. Location- and action-specific ARARs will be addressed through proper design, consultation with appropriate agencies, adherence to specific construction practices, and post-Removal Action monitoring. Location- and action-specific ARARs are driven by the following issues:

- The majority of the Removal Action Area is within the 100-year floodplain.
- In-water activities are regulated by many federal and state agencies.

- Substantive compliance with Clean Water Act (CWA) requirements, the Endangered Species Act (ESA), and Federal Emergency Management Agency (FEMA) regulations.

Alternative A is expected to comply with ARARs, and the cost of compliance is included in the estimated cost of the alternative (see Appendix O and Table 8-1).

8.2.1.3 Short-Term Effectiveness

This criterion addresses the short-term effects of an alternative during its implementation, i.e., before the RAOs have been met.

The implementation of Alternative A – including the placement of sediment caps, dredging in Slip 3 and processing, handling, and transporting the dredged sediment, the treatment and discharge of decant water, and sediment sampling associated with MNR – represents relatively little risk to the community, site workers, and the environment.

Impact to the community would primarily be associated with construction-related traffic, especially if dredged sediment wastes are transported by truck for disposal at an approved landfill. This risk would be mitigated by use of the Terminal 4 truck route (i.e., Columbia Boulevard) and by implementation of an onsite/offsite traffic plan.

Air emissions, noise, and light are not expected to affect the community beyond the effects of general conditions already prevailing at Terminal 4. Because the public does not have access to Terminal 4, exposure to contaminants and the dangers associated with specialty construction equipment is not expected during dredging and capping. Sampling activities associated with the MNR component of the alternative are expected to have negligible impact on the community.

Potential risks to site workers from exposure to contaminants and operational hazards such as light, noise, and air emissions would be mitigated by the use of personal protective equipment (PPE) as specified in a Removal Action Area-specific health and safety plan (HASP) and through the use of appropriate equipment and material handling procedures, to be specified in the design documents and the work plans. Sampling activities associated with the MNR component of the alternative will be relatively infrequent and minimally intrusive and so are expected to pose negligible potential risk to site workers.

Short-term risks to the environment during implementation of Alternative A could include:

- water quality impacts caused by the resuspension of sediment during in-water construction activities, which will be monitored by the development and implementation of a water quality monitoring plan (construction activities will be modified and additional BMPs employed in response to monitoring results, if necessary);
- operational hazards associated with on-land construction, including dust and air emissions from construction equipment, which will be mitigated by the use of appropriate dust control procedures and by the selection and regular maintenance of containment structures; and

- spills and accidental releases of the dredge material during dewatering, handling, processing, and loading for transport, which will be mitigated by devising and implementing appropriate material handling and containment procedures to reduce the potential for offsite migration of dredge material or decant water.

The schedule of construction activities associated with the implementation of the removal action alternative will be developed during the future design activities considering Port and tenant operations, infrastructure construction requirements associated with the implementation with the removal action, availability of materials, contractors, and services, as well as available in-water construction periods. Based on experience with projects of a similar size and nature performed in the Pacific Northwest, the anticipated project duration for the removal action alternative is presented below.

The duration of the in-water activities is estimated as follows:

As described in Section 7.3.2, this alternative involves the dredging of about 105,000 cy of contaminated sediment from an area of 9.2 acres, cap placement on about 20 acres, and MNR for the remainder of the Removal Action Area, about 15.9 acres.

It is estimated that in-water construction activities can be completed within two construction seasons (the in-water work window on the Willamette River is July 1 to October 31 and December 1 to January 31), with all of the dredging completed in Year 1. Impacts to the community, site workers, and the environment associated with the implementation of Alternative A are therefore limited to the relatively short time of two construction seasons, approximately six months each.

The duration of the MNR portion of Alternative A is estimated to be longer, on the order of 5 years (see Appendix H). However, short-term impacts to the community, site workers, and the environment related to the MNR component of Alternative A are considered negligible.

The overall time needed to achieve the RAOs for Terminal 4 Removal Action is estimated to be 5 years after completion of construction.

8.2.1.4 Reduction of Mobility, Volume, and Toxicity of Contaminants through Treatment

Alternative A does not involve treatment of sediments with detected contaminants. The technology screening (Appendix B) concluded that there are no practicable treatment technologies available to treat the sediments encountered at Terminal 4. Therefore, this evaluation criterion is not considered in the analysis.

8.2.1.5 Long-Term Effectiveness

Under Alternative A, approximately 45% of the Removal Action Area would be capped. Capped areas are primarily in Slip 1, under the piers and in nearshore areas of Slip 3, at the shoreline of Wheeler Bay, and at the downstream end of the Berth 401 shoreline. All capped areas satisfy ecological and human health RAOs because exposure to contaminated bed sediments by receptors of concern, or species that are components of the food web, is prevented. Mixing of bed sediment and cap material due to resuspension during placement will likely be minimal. Caps will not be constructed until dredging is complete within a given area. Therefore, the cap surface would not be impacted by sediment resuspension that may occur during dredging.

Alternative A also includes dredging most of Slip 3. Approximately 20% of the Removal Action Area would be dredged under this alternative. It is anticipated that residual COPC concentrations in dredged areas will be within acceptable levels because contaminated surface sediments will have been removed to depths at which clean sediments are revealed.

Areas over which MNR will be applied (approximately 35% of the Removal Action Area) will be monitored for 5 years after construction is complete. Based on modeling, it is anticipated that the concentrations in the MNR areas will be within acceptable levels within 5 years after completion of the Removal Action construction. Should the MNR component not achieve RAOs in the 5-year timeframe, the need for capping or dredging in areas where MNR is applied would be reconsidered. MNR areas will be assessed, in part, based on risk-based criteria and/or sediment cleanup goals developed in the harbor-wide RI/FS.

Alternative A will require the establishment of post-removal site controls, including periodic monitoring, sampling, and analyses to evaluate the performance of the Removal Action. Periodic monitoring of the MNR areas is part of this program. In addition, the capped areas will be diver inspected on a routine basis to ensure cap integrity.

Post-removal action confirmation sampling and analysis will be conducted after construction to provide direct measurement of residual conditions. Corrective actions will be taken if caps or dredged areas fail to meet performance requirements.

8.2.2 Implementability

The technical feasibility of the technology components of Alternative A and the overall feasibility of the alternative are discussed in this section.

8.2.2.1 Technical Feasibility

The technical feasibility of the alternative is addressed through individual assessment of the technical feasibility of its technology components.

MNR Component

MNR is proposed for certain portions of the Removal Action Area including along the Willamette River harbor line (Berth 401 and North of Berth 414) and in some parts of Slip 1 and Wheeler Bay. At these locations, MNR is considered a technically feasible technology. The areas selected for MNR exhibit generally low contaminant concentrations and, as discussed in Appendix H, the physical and chemical conditions are suitable for natural recovery processes to reduce the risk posed by detected contaminants in sediment. The progress and success of MNR are verifiable through periodic monitoring consisting of sediment analysis to verify that sediment concentrations are decreasing over time. If after 5 years of post-removal action monitoring, concentrations are not consistent with RAOs, additional removal action will be evaluated. Consistency with RAOs will be based, in part, on risk-based criteria and/or cleanup goals established by USEPA through the harbor-wide RI/FS process for the Portland Harbor Superfund Site.

Dredging Component

Dredging is proposed for Slip 3 in this alternative. Dredging in Slip 3 is technically feasible. Slip 3 is an active slip where dredging has already occurred a number of times for berth deepening and maintenance purposes. Dredging of contaminated sediments has been successfully conducted at a large number of Superfund sites in the Pacific Northwest under conditions similar to those at Slip 3. In Slip 3, dredging would not face serious technical difficulties that could not be mitigated. An anticipated technical difficulty will be the relatively high volume of marine traffic at Berths 410 and 411. This difficulty can be mitigated by using high-productivity dredging, perhaps multiple dredges, to minimize the disruption of Kinder Morgan operations at Berths 410 and 411. High dredge productivity must, however, be supported with matching dredge sediment hauling capacity which may be challenging.

Technologies associated with the handling, transportation, and offsite disposal of dredged sediment are all considered technically feasible and proven technologies that have been implemented at several contaminated sediment remediation projects in the Pacific Northwest. Incidental technologies, such as dewatering and the treatment and discharge of the treated decant water, are also considered technically feasible, proven technologies.

Several landfills in reasonable proximity of Terminal 4 meet USEPA landfill criteria and are authorized to receive CERCLA waste. All these landfills are accessible via rail and truck, and more than one of them is accessible by barge as well. All three forms of transportation can be technically feasible for dredged sediment.

Environmental considerations, such as fish windows, climate, weather, hydraulic, and hydrologic conditions, can be incorporated into the dredging design and implementation schedule. Furthermore, the success of dredging, i.e., the removal of the contaminated sediment, can be verified through multiple methods, including real-time surveys, bathymetric surveys, and sediment sampling.

Dredging is considered a technically mature and reliable technology that is feasible for Slip 3. The technical difficulties of dredging can be addressed by design and logistical means during design and implementation of the Removal Action.

Capping Component

Capping is proposed under Alternative A for some parts of the bottom and the side slopes of Slip 1, over the beach at Wheeler Bay, the under-pier areas at Pier 4 in Slip 3, and over the pile area at Pier 5 in Slip 3.

The placement of sediment caps over relatively flat bottoms is a common sediment remediation technology. Numerous sediment remediation projects have successfully utilized capping in conditions similar to those proposed for Slip 1. No significant technical difficulties are foreseen for the Slip 1 capping. The placement of a cap on the slopes in the Pier 5 area represents a technical challenge, because the slope is relatively steep. This challenge can be overcome by careful selection of a cap material with sufficient strength to be stable on the steep slope and by devising a method to place the cap to maintain its stability. This can be accomplished by scheduling the placement starting at the toe of the slope, using a toe berm, and building it in an upward direction.

In the under-pier areas, limited access represents another technical challenge. This can be overcome by selecting a synthetic cap, for example, concrete mattresses. The fabric component of the mattress can be placed with relative ease and precision, and the grout can be delivered using conventional concrete pumps.

Environmental considerations, such as fish windows, climate, weather, hydraulic, and hydrologic conditions, can be incorporated into the capping design, implementation, and schedule. A monitoring and maintenance program can also be established to verify that such effects (if and when they occur) do not reduce the serviceability of the cap, and repairs can be implemented to rectify any damage.

The success of a capping remedy is verifiable. Bathymetric and topographic surveys can be used to verify the thickness of the cap and post-removal action confirmation samples from the cap surface can be analyzed to verify that contaminated sediment is isolated from the water and biota.

Capping is considered a technically mature and reliable technology that is feasible for this alternative. The technical difficulties of capping can be addressed by design and logistical means during design and implementation of the Removal Action.

Future Terminal 4 and Portland Harbor Actions

Overall, the alternative is not expected to interfere with additional removal (or remedial) activities planned or anticipated within Terminal 4 or within the Portland Harbor Superfund Site.

8.2.2.2 Administrative Feasibility

Administrative feasibility evaluates those activities needed to coordinate with other offices and agencies, including statutory limits, waivers, and requirements for permits for offsite actions. Other factors that may affect administrative feasibility include the need for easements, right-of-way agreements, or zoning variances.

Statutory limits have been evaluated and do not apply because this is a potentially responsible party (PRP)-lead project. Dredging and placement of the cap material will require substantive compliance with Sections 404 and 401 of the CWA and ESA consultation. Offsite disposal of dredged material will be at a landfill that meets USEPA criteria. The Port will meet all generator requirements related to the offsite transport and disposal of the dredged material.

Additionally, agreements with Port tenants will be necessary to coordinate all work for the Removal Action and in particular with a Terminal 4 transload facility and truck or train schedules. Any agreements needed between the Oregon Department of State Lands (DSL) and the Port for work on State of Oregon submerged land will be negotiated between the Port and DSL. Similarly, the Port will coordinate with the City for work to be conducted in Wheeler Bay, as necessary, based on the City's ownership of the adjacent upland area.

The effort and cost associated with obtaining offsite permits, meeting the substantive requirements of ARARs, and coordination with DSL and the City, as well as coordinating with Port tenants, have been included in the cost estimate developed for this alternative.

8.2.2.3 Availability

Resources needed for MNR include sampling personnel; sampling equipment; relatively small, specialty vessels; and an analytical laboratory. All these resources are readily available from multiple vendors and are procurable through competitive bidding.

There are numerous dredging contractors, suitable dredging equipment, and sufficient skilled labor in the Pacific Northwest and along the West Coast to execute a contaminated sediment dredging project (see Appendix B for a discussion of dredging technologies). Resources for the dredging component of Alternative A are available from multiple vendors and are procurable through competitive bidding.

Generally there are sufficient trucking contractors available in the Portland area, however, at times demand for trucking may be high and thus procuring trucks may be a challenge. Should trucking capacity become a limiting factor on production, it would be possible to combine truck transport with other technologies, such as rail or barge. The truck route currently used for Terminal 4 traffic can provide a traffic service of Level C (Port of Portland Master Plan, 2002), which is higher than the requirements (Level D) set forth by the City of Portland. It is expected that the number of trucks associated with the waste hauling would not cause a deterioration of service to unacceptable levels.

In the case of rail transfer, it is assumed that it will be necessary to construct a barge-to-rail transload facility at the head of Slip 1. Rail reliability will be evaluated at the time of design. There may be challenges associated with having enough reliable rail service to keep up with dredging production rates.

In the case of barge haul to a landfill located along the Columbia River, the number and size of barges need to be carefully evaluated during the design of the Removal Action. Barges for sediment transport are generally available in the Pacific Northwest. If barge transport is determined to be a limiting factor on production, it would be possible to combine barge transport with other technologies such as rail and truck.

There are multiple, separately owned, and therefore competing, landfills within a practical hauling distance of Terminal 4. All of them have sufficient capacity and ample operational life to receive the sediment dredged at Terminal 4.

There are numerous marine contractors, suitable construction equipment, and sufficient skilled labor in the Pacific Northwest and along the West Coast to execute a contaminated sediment capping project (see Appendix B for a discussion of capping technologies). Resources for the capping component of Alternative A are available from multiple vendors and procurable through competitive bidding.

8.2.3 Cost

The costs associated with Alternative A include the capital cost associated with dredging, disposal of the dredged sediment, and cap installation; ongoing operations and maintenance (O&M) costs associated with capping; and periodic costs associated with MNR. The costs associated with Alternative A are:

- Capital costs: $20,899,800
- O&M and other periodic costs: $3,056,300
- Net Present Value (NPV) (2005): $23,303,000

A detailed cost estimate and relevant assumptions for Alternative A are presented in Appendix O.

8.3 Evaluation of Alternative B: Cap Emphasis

8.3.1 Effectiveness

This criterion addresses the ability of the alternative to meet the objective within the scope of the Removal Action.

8.3.1.1 Overall Protection of Public Health and the Environment

Alternative B meets the RAOs of reducing ecological and human health risks and the likelihood of recontamination. The combination of technologies proposed in Alternative B is the same as proposed in Alternative A. This alternative is expected to achieve the RAOs primarily by capping and dredging in portions of the Removal Action Area having the highest levels of detected sediment contaminants. These actions would prevent human and ecological receptors from contacting COPCs in the dredged or capped sediments.

Under Alternative B, portions of the Removal Action Area will be addressed through MNR, which consists of complex physical, chemical, and biological processes, all leading to reductions in the volume and mobility of contaminants. The MNR areas have lower levels of COPCs in sediments than the capping and dredging areas and contribute only minimally to the risk of adverse effects on human health and the environment. COPCs are found at detectable levels in sediments of the MNR areas, but active removal or capping in these areas is not expected to significantly reduce risk. In addition, these areas are the most vulnerable to recontamination from upstream sources of COPCs. Based on modeling presented in Appendix H, MNR processes are expected to provide a long-term and permanent reduction in ecological and human health risk, thus providing adequate protection against those risks. The MNR areas will be monitored and, if after 5 years of post-removal action monitoring, concentrations are not consistent with RAOs, additional removal action will be evaluated. Consistency with RAOs will be based, in part, on risk-based criteria and/or cleanup goals established by USEPA through the harbor-wide RI/FS process for the Portland Harbor Superfund Site.

With respect to the other effectiveness subcriteria, Alternative B can be designed and implemented to meet the substantive requirements of the ARARs. The alternative is expected to exhibit relatively high short-term efficiency, since its primary components (capping and dredging) pose relatively little risk to the community, site workers, and the environment, and those limited risks are of short duration. The MNR component of the alternative represents relatively little risk to the community, site workers, and the environment, although the duration of these risks is prolonged because of the longer time required to achieve protectiveness by MNR. Overall, however, no unacceptable short-term impact is foreseen.

The overall protectiveness of the alternative will be further enhanced by institutional controls for areas that are capped. Proposed controls include identification of the capped areas as no commercial vessel anchoring zones on U.S. Coast Guard navigational maps. In addition, the capped areas would be identified on Port maps/plans to ensure that the integrity is not impacted during future potential construction.

8.3.1.2 Compliance with ARARs

Action-specific compliance with ARARs addresses whether a Removal Action alternative will meet the applicable and appropriate federal and state environmental requirements or whether grounds exist for a waiver. ARARs applicable to Alternative B are presented in Table 8-1.

ARARs for Alternative B include ARARs for MNR, capping, and dredging. Chemical-specific ARARs will be addressed through implementation of the Removal Action. Location- and action-specific ARARs will be addressed through proper design, consultation with appropriate agencies, adherence to specific construction practices, and post-Removal Action environmental monitoring. Location- and action-specific ARARs are driven by the following issues:

- The majority of the Removal Action area is within the 100-year floodplain.
- In-water activities are regulated by many federal and state agencies.
- Substantive compliance with Clean Water Act (CWA) requirements, the Endangered Species Act (ESA), and Federal Emergency Management Agency (FEMA).

Alternative B is expected to comply with ARARs, and the cost of compliance is included in the estimated cost of the alternative (see Appendix O and Table 8-1).

8.3.1.3 Short-Term Effectiveness

This criterion addresses the short-term effects of an alternative during its implementation, i.e., before the RAOs have been met.

The implementation of Alternative B – including the placement of sediment caps, dredging in Slip 3 and processing, handling, and transporting the dredged sediment, the treatment and discharge of the decant water, and sediment sampling associated with the MNR – represents moderate risk to the community, site workers, and the environment.

Impact to the community would primarily be associated with construction-related traffic, especially if dredged sediment wastes are transported by truck for disposal at an approved landfill. This risk would be mitigated by use of the Terminal 4 truck route (i.e., Columbia Boulevard) and by implementation of an onsite/offsite traffic plan.

Air emissions, noise, and light are not expected to affect the community beyond the effects of the general conditions already prevailing at Terminal 4. Because the public does not have access to Terminal 4, exposure to contaminants and the dangers associated with specialty construction equipment is not expected during dredging and capping. Sampling activities associated with the MNR component of the alternative are expected to have negligible impact on the community.

Potential risks to site workers from exposure to contaminants and operational hazards such as light, noise, and air emissions would be mitigated by the use of PPE as specified in a Removal Action Area-specific HASP and through the use of appropriate equipment and material handling procedures, to be specified in the design documents and the work plans. Sampling activities associated with the MNR component of the alternative will be relatively infrequent and minimally intrusive and so are expected to pose negligible potential risk to site workers.

Short-term risks to the environment during the implementation of Alternative B could include:

- water quality impacts caused by the resuspension of sediment during in-water construction activities, which will be monitored by the development and implementation of a water quality monitoring plan (construction activities will be modified and additional BMPs employed in response to monitoring results, if necessary);
- operational hazards associated with on-land construction, including dust and air emissions from construction equipment, which will be mitigated by the use of appropriate dust control procedures and by the selection and regular maintenance of containment structures; and
- spills and accidental releases of the dredge material during dewatering, handling, processing, and loading for transport, which will be mitigated by devising and implementing appropriate material handling and containment procedures to reduce the potential for offsite migration of dredge material or decant water.

The schedule of construction activities associated with the implementation of the removal action alternative will be developed during the future design activities considering Port and tenant operations, infrastructure construction requirements associated with the implementation with the removal action, availability of materials, contractors, and services, as well as available in-water construction periods. Based on experience with projects of a similar size and nature performed in the Pacific Northwest, the anticipated project duration for the removal action alternative is presented below.

The duration of the in-water activities is estimated as follows:

As described in Section 7.3.3, this alternative involves the dredging of about 105,000 cy of contaminated sediment, cap placement on about 24.2 acres, and MNR for the remainder of the Removal Action Area, about 11.7 acres.

It is estimated that the in-water construction activities can be completed over two construction seasons (the in-water work window on the Willamette River is July 1 to October 31 and December 1 to January 31), with all of the dredging completed in Year 1. Impacts to the community, site workers, and the environment associated with the implementation of Alternative B are therefore limited to the relatively short time of one or two construction seasons, approximately six months each.

The duration of the MNR portion of Alternative B is estimated at 5 years (see Appendix H). However, short-term impacts to the community, site workers, and environment related to the MNR component of Alternative B are considered negligible.

The time needed to achieve required protection is estimated at 2 years for those subareas where capping and dredging are planned and 5 years after completion of construction for those subareas where MNR is planned.

8.3.1.4 Reduction of Mobility, Volume, and Toxicity of Contaminants through Treatment

The alternative does not involve treatment of sediments with detected contaminants. The technology screening (Appendix B) concluded that there are no practicable treatment technologies available to treat the sediments encountered at Terminal 4. Therefore, this evaluation criterion is not considered in the analysis.

8.3.1.5 Long-Term Effectiveness

Under Alternative B, approximately 54% of the Removal Action Area would be capped. Capped areas are the same as for Alternative A, but include a more extensive cap in Slip 1. Caps would also be constructed under the piers and in nearshore areas of Slip 3, at the shoreline of Wheeler Bay, and at the downstream end of the Berth 401 shoreline.

All capped areas satisfy ecological and human health RAOs because exposure to contaminated bed sediments by receptors of concern, or species that are components of the food web, is prevented. Mixing of bed sediment and cap material due to resuspension during placement will likely be minimal. Caps will not be constructed until dredging is complete within a given area. Therefore, the cap surface would not be impacted by sediment resuspension that may occur during dredging.

The proportionate amount of dredging in Alternative B would be the same as for Alternative A (20% of the Removal Action Area), all in Slip 3. It is anticipated that residual COPC concentrations in dredged areas will be within acceptable levels because contaminated surface sediments will have been removed to depths at which clean sediments are revealed.

The area over which MNR will be applied is approximately 26%, which is less than in Alternative A due to the extended cap in Slip 1. MNR areas will be monitored for 5 years after construction is complete. It is anticipated that the concentrations in the MNR areas will be within acceptable levels within 5 years after completion of the Removal Action construction. Should the MNR component not achieve RAOs in the 5-year timeframe, the need for capping or dredging in areas where MNR is applied would be reconsidered. MNR areas will be assessed, in part, based on risk-based criteria and/or sediment cleanup goals developed in the harbor-wide RI/FS.

Alternative B will require the establishment of post-removal site controls, including periodic monitoring, sampling, and analyses to evaluate the performance of the Removal Action. Periodic monitoring of the MNR areas is part of this program. In addition, the capped areas will be diver inspected on a routine basis to ensure cap integrity.

Post-removal action confirmation sampling and analysis will be conducted after construction to provide direct measurement of residual conditions. Corrective actions will be taken if caps or dredged areas fail to meet performance requirements.

8.3.2 Implementability

The technical feasibility of the technology components of Alternative B and the overall feasibility of the alternative are discussed in this section.

8.3.2.1 Technical Feasibility

The technical feasibility of the alternative is addressed through individual assessment of the technical feasibility of its technology components.

Capping Component

Capping is proposed for the entire bottom and the side slopes of Slip 1, on the slopes behind Berth 401, over the beach at Wheeler Bay, the under-pier areas for Pier 4 in Slip 3, and over the pile area at Pier 5 in Slip 3.

The placement of sediment caps over relatively flat bottoms is a common sediment remediation technology. Numerous sediment remediation projects have successfully utilized capping in conditions similar to those proposed for Slip 1. No significant technical difficulties are foreseen for the Slip 1 capping.

The placement of a cap on the slopes in the Pier 5 area represents a technical challenge, because the slope is relatively steep. This challenge can be overcome by careful selection of a cap material with sufficient strength to be stable on the steep slope and by devising a method to place the cap to maintain its stability. This can be accomplished by scheduling the placement starting at the toe of the slope, using a toe berm, and building it in an upward direction.

In the under-pier areas, limited access represents another technical challenge. This can be overcome by selecting a synthetic cap, for example, concrete mattresses. The fabric component of the mattress can be placed with relative ease and precision, and the grout can be delivered using conventional concrete pumps.

Environmental considerations, such as fish windows, climate, weather, hydraulic, and hydrologic conditions, can be incorporated into the capping design, implementation, and schedule. A monitoring and maintenance program can also be established to verify that such effects (if and when they occur) do not reduce the serviceability of the cap, and repairs can be implemented to rectify any damage.

The success of a capping remedy is verifiable. Bathymetric and topographic surveys can be used to verify the thickness of the cap and post-removal action confirmation samples from the cap surface can be analyzed to verify that contaminated sediment is isolated from the water and biota.

Capping is considered a technically mature and reliable technology that is feasible for this alternative. The technical difficulties of capping can be addressed by design and logistical means during design and implementation of the Removal Action.

MNR Component

MNR is proposed for certain portions of the Removal Action Area including along the Willamette River harbor line (Berth 401 and North of Berth 414) and Wheeler Bay. At these locations, MNR is considered a technically feasible technology. The areas selected for MNR exhibit generally low contaminant concentrations and, as discussed in Appendix H, the physical and chemical conditions are suitable for natural recovery processes to reduce the risk posed by contamination in sediment. The progress and success of MNR are verifiable through periodic monitoring consisting of sediment analysis to verify that sediment concentrations are decreasing over time. If after 5 years of post-removal action monitoring, concentrations are not consistent with RAOs, additional removal action will be evaluated. Consistency with RAOs will be based, in part, on risk-based criteria and/or cleanup goals established by USEPA through the harbor-wide RI/FS process for the Portland Harbor Superfund Site.

Dredging Component

Dredging is proposed for Slip 3 in this alternative. Dredging in Slip 3 is technically feasible. Slip 3 is an active slip where dredging has already occurred a number of times for berth deepening and maintenance purposes. Dredging of contaminated sediments has been successfully conducted at a large number of Superfund sites in the Pacific Northwest under conditions similar to those at Slip 3. In Slip 3, dredging would not face serious technical difficulties that could not be mitigated. An anticipated technical difficulty will be the high volume of marine traffic at Berths 410 and 411. This difficulty can be mitigated by using high-productivity dredging, perhaps multiple dredges, to minimize the disruption of Kinder Morgan operations at Berths 410 and 411. High dredge productivity must, however, be supported with matching dredge sediment hauling capacity which may be challenging.

Technologies associated with the handling, transportation, and offsite disposal of dredged sediment are all considered technically feasible and proven technologies that have been implemented at several contaminated sediment remediation projects in the Pacific Northwest.

Incidental technologies, such as dewatering and the treatment and discharge of the treated decant water, are also considered technically feasible, proven technologies.

Several landfills in reasonable proximity of Terminal 4 meet USEPA landfill criteria and are authorized to receive CERCLA waste. All these landfills are accessible via rail and truck, and more than one of them is accessible by barge as well. Terminal 4 has access to freeways and to rail as well as several berths. All three forms of transportation can be technically feasible for dredged sediment.

Environmental considerations, such as fish windows, climate, weather, hydraulic, and hydrologic conditions, can be incorporated into the dredging design and implementation schedule. Furthermore, the success of dredging, i.e., the removal of the contaminated sediment, can be verified through multiple methods, including real-time surveys, bathymetric surveys, and sediment sampling.

Dredging is considered a technically mature and reliable technology that is feasible for Slip 3. The technical difficulties of dredging can be addressed by design and logistical means during design and implementation of the Removal Action.

Future Terminal 4 and Portland Harbor Actions

Overall, the alternative is not expected to interfere with additional removal (or remedial) activities planned or anticipated within Terminal 4 or within the Portland Harbor Superfund Site.

8.3.2.2 Administrative Feasibility

Administrative feasibility evaluates those activities needed to coordinate with other offices and agencies, including statutory limits, waivers, and requirements for permits for offsite actions. Other factors that may affect administrative feasibility include the need for easements, right-of-way agreements, or zoning variances.

Statutory limits do not apply because this is a PRP-lead project. Dredging and placement of the cap material will require substantive compliance with Sections 401 and 404 of the CWA and ESA consultation. Offsite disposal of dredged material will be at a landfill that meets USEPA criteria. The Port will meet all generator requirements related to the offsite transport and disposal of the dredged material.

Additionally, agreements with Port tenants will be necessary to coordinate all work for the Removal Action and in particular with a Terminal 4 transload facility and truck or train schedules. Any agreements needed between DSL and the Port for work to be done on State of Oregon submerged land will be negotiated between the Port and DSL. Similarly, the Port will coordinate with the City for work to be conducted in Wheeler Bay, as necessary, based on the City's ownership of the adjacent upland area.

The effort and cost associated with obtaining offsite permits, meeting the substantive requirements of ARARs, and coordination with DSL and the City, as well as coordinating with Port tenants, have been included in the cost estimate developed for this alternative.

8.3.2.3 Availability

There are numerous marine contractors, suitable construction equipment, and sufficient skilled labor in the Pacific Northwest and along the West Coast to execute a contaminated sediment capping project (see Appendix B for a discussion of capping technologies). Resources for the capping component of Alternative B are available from multiple vendors and procurable through competitive bidding.

Resources needed for MNR include sampling personnel; sampling equipment; relatively small, specialty vessels; and an analytical laboratory. All these resources are readily available from multiple vendors and are procurable through competitive bidding.

There are numerous dredging contractors, suitable dredging equipment, and sufficient skilled labor in the Pacific Northwest and along the West Coast to execute a contaminated sediment dredging project (see Appendix B for a discussion of dredging technologies). Resources for the dredging component of Alternative B are available from multiple vendors and are procurable through competitive bidding.

Generally there are sufficient trucking contractors available in the Portland area, however, at times demand for trucking may be high and thus procuring trucks may be a challenge. Should trucking capacity become a limiting factor on production, it would be possible to combine truck transport with other technologies, such as rail or barge. The truck route currently used for Terminal 4 traffic can provide a traffic service of Level C (Port of Portland Master Plan, 2002), which is higher than the requirements (Level D) set forth by the City of Portland. Using truck haul, it is expected that the number of trucks associated with the waste hauling would not cause a deterioration of service to unacceptable levels.

In the case of rail transfer, it is assumed that it will be necessary to construct a barge-to-rail transload facility at the head of Slip 1. Rail reliability will be evaluated at the time of design. There may be challenges associated with having enough reliable rail service to keep up with dredging production rates.

In the case of barge haul to a landfill located along the Columbia River, the number and size of barges need to be carefully evaluated during the design of the Removal Action. Barges for sediment transport are generally available in the Pacific Northwest. If barge transport is determined to be a limiting factor on production, it would be possible to combine barge transport with other technologies such as rail and truck.

There are multiple, separately owned, and therefore competing, landfills within a practical hauling distance of Terminal 4. All these have sufficient capacity and ample operational life to receive the sediment dredged at Terminal 4.

8.3.3 Cost

The costs associated with Alternative B include the capital cost associated with sediment cap installation, dredging, and disposal of the dredged sediment; ongoing O&M costs associated with capping; and periodic costs associated with MNR. The costs associated with Alternative B are:

- Capital costs: $22,258,550
- O&M and other periodic costs: $3,215,900
- NPV (2005): $24,627,000

A detailed cost estimate and relevant assumptions for Alternative B are presented in Appendix O.

8.4 Evaluation of Alternative C: Dredge Emphasis with CDF Disposal

8.4.1 Effectiveness

This criterion addresses the ability of the alternative to meet the objective within the scope of the Removal Action.

8.4.1.1 Overall Protection of Public Health and the Environment

Alternative C meets the RAOs of reducing ecological and human health risks and the likelihood of recontamination. This alternative is expected to achieve the RAOs through a number of means, primarily by removing sediments with detected contaminants through dredging and by containing them in a CDF. In addition, Alternative C utilizes capping, as well as the physical, chemical, and biological processes of MNR in areas of low levels of detected contaminants. Alternative C represents a low potential for recontamination during implementation, and potential recontamination will be limited to areas where resuspension of sediments during removal activities (e.g., dredging) could occur. This alternative provides the potential to utilize certain dredging technologies that, among other benefits, can be executed with little resuspension.

Alternative C can be designed and implemented to meet the substantive requirements of the ARARs. The alternative is expected to exhibit relatively high short-term efficiency, since its main components of dredging and CDF construction represent relatively little risk to the community, to site workers, and to the environment, and the duration of these activities is relatively short. In addition, the CDF component adds a long-term benefit to the community because the excess capacity will provide a nearby CDF for other suitable sediments removed during the Portland Harbor remedial action or individual removal actions, minimizing sediment handling, transport, and other associated short-term environmental impacts to the local area, and potentially expediting other sediment clean up projects. The MNR component of the alternative poses negligible risk to the community, site workers, and the environment. Other technology components of the alternative are expected to exhibit somewhat less short-term efficiency, because they involve more site activities; however, no unacceptable short-term impact is foreseen.

The overall protectiveness of the alternative will be further enhanced by institutional controls for areas that are capped and the CDF. For capping, proposed controls include identification of the capped areas as no commercial vessel anchoring zones. These areas would be identified on U.S. Coast Guard navigational maps. In addition, the capped areas would be identified on Port maps/plans to ensure that the integrity is not impacted during future potential construction. Proposed institutional controls for the CDF include the following: (1) notification to tenants adjacent to the CDF; (2) specific lease language for future tenants who would occupy the land above the CDF notifying them of the CDF and restricting their construction activities based on the presence of the CDF; (3) including the CDF on Port plans/maps of the area; and (4) an easement on the CDF land that restricts activity below a specific elevation.

8.4.1.2 Compliance with ARARs

Compliance with ARARs addresses whether a Removal Action alternative will meet the applicable and appropriate federal and state environmental requirements or whether grounds exist for a waiver. ARARs applicable to Alternative C are presented in Table 8-1.

Action-specific ARARs for Alternative C include ARARs for MNR, capping, dredging, and CDFs. Chemical-specific ARARs will be addressed through implementation of the Removal Action. Location- and action-specific ARARs will be addressed through proper design, consultation with appropriate agencies, adherence to specific construction practices, and post-Removal Action environmental monitoring. Location- and action-specific ARARs are driven by the following issues:

- The majority of the Removal Action area is within the 100-year floodplain.
- In-water activities are regulated by many federal and state agencies.
- Substantive compliance with Clean Water Act (CWA) requirements, the Endangered Species Act (ESA), and Federal Emergency Management Agency (FEMA) regulations.

Alternative C is expected to comply with ARARs, and the cost of compliance is included in the estimated cost of the alternative (see Appendix O and Table 8-1).

8.4.1.3 Short-Term Effectiveness

This criterion addresses the short-term effects of an alternative during implementation, i.e., before the RAOs have been met.

The implementation of Alternative C – including construction of a CDF in Slip 1, placement of sediment caps over a relatively small portion of the Removal Action Area, dredging in Slip 3 and the handling, transport, and discharge of the sediment into the CDF, and sediment sampling associated with MNR at relatively limited portions of the Removal Action Area – represents very low risk to the community, site workers, and the environment.

Impact to the community would be essentially negligible because construction-related traffic would not include any sizeable amount of trucking for waste disposal, but would be limited to the movement of supplies and personnel. This negligible remaining risk would be further mitigated by use of the Terminal 4 truck route (i.e., Columbia Boulevard) and by implementation of an onsite/offsite traffic plan. Essentially, all Removal Action construction-related activity would be conducted on Port property with very little impact to the surrounding areas. Based on other, similar CDF construction projects in the Pacific Northwest, it is expected that material to be used for construction of the CDF berm will be delivered and placed by barges, i.e., with no increase in truck traffic.

Air emissions, noise, and light are not expected to affect the community beyond the effects of general conditions already prevailing at Terminal 4. Because the public does not have access to Terminal 4, exposure to contaminants and the dangers associated with specialty construction equipment is not expected. Negligible impact to the community is expected from sampling activities associated with the MNR component of the alternative.

Potential risks to site workers from exposure to contaminants and operational hazards such as light, noise, and air emissions would be mitigated by the use of PPE as specified in a Removal Action Area-specific HASP and through the use of appropriate equipment and material handling procedures, to be specified in the design documents and the work plans. Sampling activities associated with the MNR component of the alternative will be relatively infrequent and minimally intrusive and so are expected to pose negligible potential risk to site workers.

Short-term risks to the environment during implementation of Alternative C could include:

- water quality impacts caused by the resuspension of sediment during in-water construction activities, including dredging, capping, and CDF construction, which will be monitored by the development and implementation of a water quality monitoring plan (construction activities will be modified and additional BMPs employed in response to monitoring results, if necessary);
- operational hazards associated with ancillary on-land construction activities, including dust and air emissions from construction equipment, which will be mitigated by the use of appropriate dust control procedures and by the selection and regular maintenance of containment structures; and
- spills and accidental releases of the dredge material during handling and filling into the CDF (if an overland route is utilized), which will be mitigated by devising and implementing appropriate material handling and containment procedures to reduce the potential for offsite migration of dredge material or decant water.

Overall, CDF construction represents little risk to the environment because:

- the placement of the berm involves clean, inert materials; and
- the filling of the CDF is isolated from the Willamette River by the berm.

The schedule of construction activities associated with the implementation of the removal action alternative will be developed during the future design activities considering Port and tenant operations, infrastructure construction requirements associated with the implementation with the removal action, availability of materials, contractors, and services, as well as available in-water construction periods. Based on our experience with projects of a similar size and nature performed in the Pacific Northwest, the anticipated project duration for the removal action alternative is presented below.

The duration of the in-water activities is estimated as follows:

As described in Section 7.3.4, this alternative involves the construction of a CDF involving the placement of a containment berm of 138,500 cy, the dredging of about 115,000 cy of contaminated sediment mainly from Slip 3, the filling of this material into the CDF, and the placement of sediment caps over a total area of about 9 acres, as well as MNR on the rest of the Removal Action Area, affecting about 11 acres. Upon the completion of the filling of the excess capacity in the CDF, its final engineering cap of about 255,000 cy will be placed.

It is estimated that the infrastructure construction requirements, preparatory dredging (under the footprint of the CDF berm) and the construction of the berm, the dredging in Slip 3 and the filling of this material into the CDF, and the placement of the sediment caps can be completed in three construction seasons.

Complete filling of the CDF is expected to span several construction seasons. The total capacity of the CDF allows filling from other contaminated sediment locations in the Portland Harbor Superfund Site. After filling the CDF with sediments from Terminal 4, there is an estimated excess capacity of 560,000 cy for dredged sediments from other cleanup projects in the Superfund Site. The volume of sediment coming from other sites and the schedule of dredging, and therefore the schedule of the filling of the CDF, are not known at this time. Therefore, the overall duration of the in-water activities associated with the CDF construction and filling may span several construction seasons. However, these activities are not expected to impact water quality, since the filling of the CDF would be accomplished behind its berm, which will be designed and constructed to provide effective isolation of the filling operations from the Willamette River. As the filling of the CDF nears completion, filling rates may have to be controlled to ensure that water levels in the CDF do not rise so fast that out flow of turbid water would occur.

The duration of the MNR portion of Alternative C is estimated at 5 years (see Appendix H). However, the short-term impacts to the community, site workers, and environment related to the MNR component of Alternative C are considered negligible.

The time needed to achieve required protection is estimated at 2.5 years for those subareas where capping and dredging are planned and 5 years after completion of construction for those subareas where MNR is planned.

8.4.1.4 Reduction of Mobility, Volume, and Toxicity of Contaminants through Treatment

The alternative does not involve treatment of sediments with detected contaminants. The technology screening (Appendix B) concluded that there are no practicable treatment technologies available to treat the sediments encountered at Terminal 4. Therefore, this evaluation criterion is not considered in the analysis.

8.4.1.5 Long-Term Effectiveness

The configuration of Alternative C is the same as for Alternative B, but instead of a cap in Slip 1, there would be a CDF built to grade. The footprint of the CDF is similar to the cap described for Alternative B. Approximately

15 acres of submerged areas would be converted to land surface under Alternative C. The remainder of the alternative is identical to Alternatives A and B. As a result, 19% of the Removal Action Area would be covered by a cap and 57% of the Removal Action would be a CDF. Aside from the Slip 1 CDF, capped areas are the same as for Alternatives A and B. Caps would also be constructed under the piers and in nearshore areas of Slip 3, at the shoreline of Wheeler Bay, and at the downstream end of the Berth 401 shoreline. All capped areas and the CDF satisfy ecological and human health RAOs because exposure to contaminated bed sediments by receptors of concern, or species that are components of the food web, is prevented. Mixing of bed sediment and cap material due to resuspension during placement will likely be minimal. Caps will not be constructed until dredging is complete within a given area. Therefore, the cap surface would not be impacted by sediment resuspension that may occur during dredging.

Dredging in Alternative C is the same as proposed for Alternative B, approximately 20% of the overall Removal Action Area. It is anticipated that residual COPC concentrations in sediment in dredged areas will be within acceptable levels because contaminated surface sediments will have been removed to depths at which clean sediments are revealed. Alternative C includes approximately the same area for MNR as was described for Alternative B, approximately 26% of the Removal Action Area. MNR areas will be monitored for 5 years after construction is complete. It is anticipated that the concentrations in the MNR areas will be within acceptable levels within 5 years after completion of the Removal Action construction.

Alternative C will require the establishment of post-removal site controls, including periodic monitoring, sampling, and analyses to evaluate the progress of the Removal Action and to verify the long-term adequacy of the performance of the sediment caps and the CDF. Corrective actions will be taken if the caps or CDF fail to meet performance requirements. Should the MNR component not achieve RAOs in the 5-year timeframe the need for capping or dredging in areas where MNR is applied would be reconsidered. MNR areas will be assessed, in part, based on risk-based criteria and/or sediment cleanup goals developed in the harbor wide RI/FS.

8.4.2 Implementability

The technical feasibility of the main technology components of Alternative C and the overall feasibility of the alternative are discussed in this section.

8.4.2.1 Technical Feasibility

The technical feasibility of the alternative is addressed through individual assessment of the technical feasibility of its technology components.

Dredging Component

Dredging is proposed for the footprint of the CDF berm and in Slip 3. Dredging at these areas is technically feasible. In this alternative, the required partial Slip 1 dredging would take place first, followed by construction of the containment berm of the CDF. This would be followed by dredging in Slip 3.

Slip 3 is an active slip where dredging has already occurred a number of times for berth deepening and maintenance purposes. Dredging of contaminated sediments has been successfully conducted at a large number of Superfund sites in the Pacific Northwest under conditions similar to those at Slip 3. In Slip 3, dredging would not face serious technical difficulties that could not be mitigated. An anticipated technical difficulty will be the high volume of marine traffic at Berths 410 and 411. This difficulty can be mitigated by using high-productivity dredging, perhaps multiple dredges, to reduce construction-related impacts to ecological receptors as well as to minimize the disruption of Kinder Morgan operations at Berths 410 and 411. High dredge productivity must, however, be supported with matching dredge sediment hauling/transport capacity, although since the dredged sediment would be placed in the CDF in Slip 1, the hauling/transport would be over a very short distance. Hydraulic and hydraulic cutterhead dredges are often used in the filling of CDFs to fluidize the sediment and deliver it to the CDF in a slurry form. This technology would also allow meeting the potentially high productivity requirements. Mechanical dredging and transportation of the sediment using barges and delivered to the CDF by hydraulic transport or double handling over the berm is also a technically feasible option but would likely take longer than hydraulic techniques. To further minimize impact to ecological receptors and also the disruption to tenant operations, both hydraulic or hydraulic cutterhead and mechanical dredging could be employed concurrently within Slip 3.

Technologies associated with the handling, transportation, and CDF placement of dredged sediment are all considered technically feasible and proven technologies that have been implemented successfully at several contaminated sediment remediation projects in the Pacific Northwest.

Environmental considerations, such as fish windows, climate, weather, hydraulic, and hydrologic conditions, can be incorporated into the dredging design and implementation schedule. Furthermore, the success of dredging, i.e., the removal of the contaminated sediment, can be verified through multiple methods, including real-time surveys, bathymetric surveys, and sediment sampling.

Dredging is considered a technically mature and reliable technology that is feasible for Slip 3. The technical difficulties of dredging can be addressed by design and logistical means during design and implementation of the Removal Action.

CDF Component

A number of technical issues are associated with the feasibility of constructing a CDF, as presented in Appendix K. Unique technical issues to be considered when planning and designing a CDF include:

- overall structural strength and stability of the CDF berm;
- long-term water quality impacts, i.e., the need to ensure that no unacceptable levels of dissolved-phase contaminants pass through the containment berm;
- short-term water quality impacts, i.e., the need to ensure no unacceptable levels of dissolved- and suspended-phase contaminants leaving the CDF area during its construction and filling;
- consolidation and settlement of the dredged sediment placed in the CDF; and
- potential impacts on Willamette River flood stage.

These design issues are evaluated in Appendix K; a summary of that evaluation follows.

Overall Structural Strength and Stability of the CDF Berm: The evaluations (presented in Appendix K) support that the CDF can be designed and constructed to meet the structural strength and stability requirements for the Portland area. Because Portland is in a seismically active area, the impact of seismic events on structures needs special consideration. Preliminary analyses indicate that liquefaction occurs within the foundation soils below the berm and within the dredged fill, under seismic design events of operating level event (OLE) (72-year return) and contingency level event (CLE) (475-year return). For the CLE, liquefaction would extend under the CDF berm slope but would not extend as far under the berm as the OLE. No liquefaction was indicated under the crest of the containment berm for either the CLE or OLE. The liquefaction may cause excessive settlement under the containment berm and thus the berm could potentially experience relatively large deformations. For the OLE, the deformations should not immediately affect Port operations. More substantial liquefaction and resulting deformations of the berm are expected under the CLE. However, it is not expected that the berm deformation would lead to the release of contaminated sediment for either events. The CDF would have to be inspected following seismic events and any damage to the CDF berm or CDF cap would be repaired.

Long-Term Water Quality Impacts. Preliminary fate and transport analyses show that water quality would meet the criteria for existing long-term water quality standards.

Short-Term Water Quality Impacts. As discussed above, the CDF may be filled with sediment delivered in slurry form if hydraulic or hydraulic cutterhead dredging is used, or it may be filled using barges and delivered to the CDF by hydraulic transport or double handling over the berm if mechanical dredging is used in Slip 3. Numerous resuspension containment techniques, including controlled placement of the sediment and various containment structures (such as silt curtains and turbidity curtains), are available for meeting water quality criteria established for the CDF construction period.

Consolidation and Settlement. Because of the relatively high sand content of the Terminal 4 sediments to be placed in the CDF, consolidation will occur relatively quickly and is not expected to cause construction delays. Additional sediment or other material may be filled into the CDF over several construction seasons. It is expected that the settlement of these materials will develop during or shortly after placement. The design, construction, and scheduling of the final cap placement will take into account the consolidation of the fill and will include measures to ensure uniform settlement, representing little impact to the structural integrity of the cap over the sediment filled in the CDF.

Potential Impacts on Willamette River Flood Stage and Flood Storage. An assessment of potential impacts to the Willamette River demonstrated that no rise in the base flood elevations would result from the CDF and the action would comply with FEMA regulations. An assessment of the flood storage was also conducted. Although a portion of the CDF will be located above the non-storm winter stage and some flood storage will be lost from filling Slip 1, this volume of flood storage has an insignificant effect in reducing flood hazard. As a result, no noticeable increase in peak discharge is predicted and the loss of flood storage from the CDF would not have a noticeable impact downstream.

As detailed in Appendix K, the construction of a CDF in Slip 1 is considered technically feasible. CDF construction is considered a mature, reliable technology extensively used to manage contaminated sediment, with numerous project examples in the Pacific Northwest.

MNR Component

MNR is proposed for certain portions of the Removal Action Area including along the Willamette River harbor line (Berth 401 and North of Berth 414) and Wheeler Bay. At these locations, MNR is considered a technically feasible technology. The areas selected for MNR exhibit generally low contaminant concentrations and, as discussed in Appendix H, the physical and chemical conditions are suitable for natural recovery processes to reduce the risk posed by contamination in sediment. The progress and success of MNR are verifiable through periodic monitoring consisting of sediment analysis to verify that sediment concentrations are decreasing over time. If after 5 years of post-removal action monitoring, concentrations are not consistent with RAOs, additional removal action will be evaluated. Consistency with RAOs will be based, in part, on risk-based criteria and/or cleanup goals established by USEPA through the harbor-wide RI/FS process for the Portland Harbor Superfund Site.

Capping Component

Capping in this alternative is proposed for a relatively small area along Berth 401, the beach at Wheeler Bay, the under-pier areas for Pier 4 in Slip 3, and over the pile area at Pier 5 in Slip 3.

The placement of sediment caps over relatively flat bottoms is a common sediment remediation technology. Numerous sediment remediation projects have successfully utilized capping in conditions similar to those proposed for Slip 1. No significant technical difficulties are foreseen for the Slip 1 capping.

The placement of a cap on the slopes in the Pier 5 area represents a technical challenge, because the slope is relatively steep. This challenge can be overcome by careful selection of a cap material with sufficient strength to be stable on the steep slope and by devising a method to place the cap to maintain its stability. This can be accomplished by scheduling the placement starting at the toe of the slope and building it in an upward direction.

In the under-pier areas, limited access represents another technical challenge. This can be overcome by selecting a synthetic cap, for example, concrete mattresses. The fabric component of the mattress can be placed with relative ease and precision, and the grout can be delivered using conventional concrete pumps.

Environmental considerations, such as fish windows, climate, weather, hydraulic, and hydrologic conditions, can be incorporated into the capping design, implementation, and schedule. A monitoring and maintenance program can also be established to verify that such effects (if and when they occur) do not reduce the serviceability of the cap, and repairs can be implemented to rectify any damage.

The success of a capping remedy is verifiable. Bathymetric and topographic surveys can be used to verify the thickness of the cap, and post-removal action confirmation samples from the cap surface can be analyzed to verify that contaminated sediment is isolated from the water and biota.

Capping is considered a technically mature and reliable technology that is feasible for this alternative. The technical difficulties of capping can be addressed by design and logistical means during design and implementation of the Removal Action.

Future Terminal 4 and Portland Harbor Actions

As described in Section 7.3, Alternative C provides excess dredge sediment disposal capacity of about 560,000 cy after filling with Terminal 4 sediments and would be available for the placement of suitable contaminated dredged sediment. Therefore, Alternative C provides a disposal option that could also be available to other contaminated sediment locations within the Portland Harbor Site. If the sediment is demonstrated to have the appropriate qualities (either without or following treatment) for disposal at the CDF (e.g., limited leaching capacity of the contaminants), it could be placed in the CDF at Slip 1. The excess capacity above the water table, estimated at 245,000 cy, which could become partially saturated, would allow the placement of fill. The engineering cap, consisting of approximately 255,000 cy, would be placed over the fill.

The criteria for evaluating sediments for placement in the CDF at Slip 1 will be developed during the design of the Removal Action. In addition, a management plan for handling and placement of dredged sediments from the Portland Harbor Site will be developed. Cleanup projects which include options for disposal of dredged materials in the CDF will be required to assess the criteria and management plan provisions to determine the feasibility of using the CDF for disposal. Because it will have already been constructed, the Slip 1 CDF will also offer the flexibility when executing additional removal/remedial actions at other sites within the Portland Harbor.

The availability of the excess capacity provides a disposal site that is efficient and cost-effective and can decrease the hauling/disposal/treatment of contaminated sediment for other sites within the Portland Harbor Superfund Site. This would contribute to the efficient, cost-effective performance of the long-term remedial action for the entire Superfund Site, in compliance with CERCLA 104(a)(2).

There is a precedent in Region 10 for Port authorities to construct and operate a CDF for the management of contaminated sediment sites; the Port of Tacoma's CDFs in the Blair, Sitcum, and St. Paul waterways serve as examples. This precedent indicates regulatory support for the approach.

Currently, the timeframe for filling the CDF from any sources other than Slip 3 is unknown and depends on the regulatory process at other contaminated sediment sites (estimated at 6 years) and the scheduling of ongoing maintenance dredging by the Port.

8.4.2.2 Administrative Feasibility

Administrative feasibility evaluates those activities needed to coordinate with other offices and agencies, including statutory limits, waivers, and requirements for permits for offsite actions. Other factors that may affect administrative feasibility include the need for easements, right-of-way agreements, or zoning variances. Alternative C would be conducted primarily on Port property. A portion of the CDF would be constructed on State of Oregon property, resulting in a need for administrative coordination and, ultimately, transfer of property rights to the Port.

Statutory limits do not apply because this is a PRP-lead project. Dredging, construction of the CDF and placement of the cap material will require substantive compliance with Sections 401 and 404 of the CWA and ESA consultation. Any agreements needed between DSL and the Port for work to be done on State of Oregon land will be negotiated between the Port and DSL. Similarly, the Port will coordinate with the City for work to be conducted in Wheeler Bay, as necessary, based on the City's ownership of the adjacent upland area.

Additionally, agreements with Port tenants will be necessary to coordinate all work for the Removal Action. As mentioned above, Alternative C allows the use of high-productivity dredging, so that the interference with tenant operations is considered relatively small and possibly limited to the duration of tenant interruption currently stipulated in tenant leases.

The effort and cost associated with obtaining off-site permits, meeting the substantive requirements of ARARs, and coordinating with DSL and the City, as well as coordinating with Port tenants, have been included in the cost estimate developed for this alternative.

8.4.2.3 Availability

There are numerous dredging contractors, suitable dredging equipment, and sufficient skilled labor in the Pacific Northwest and along the West Coast to execute a contaminated sediment dredging project (see Appendix B for a discussion of dredging technologies). Resources for the dredging component of Alternative C are available from multiple vendors and are procurable through competitive bidding.

Resources required for CDF construction include equipment and labor similar to that required for dredging, and these resources are readily available in the Pacific Northwest. CDF construction also involves the placement of relatively large quantities of clean, inert berm material. This need will be filled through procurement from various earth and soil material suppliers, quarries, or other sources.

Resources needed for MNR include sampling personnel; sampling equipment; relatively small, specialty vessels; and an analytical laboratory. All these resources are readily available from multiple vendors and are procurable through competitive bidding.

Under Alternative C, offsite disposal would be limited to the disposal of construction-related waste, and there is sufficient landfill capacity to facilitate this disposal need. No dredged sediment would be disposed of offsite, thus Alternative C does not depend on the availability of landfill capacity suitable for dredged sediment disposal or transportation reliability and availability (rail, truck, barge).

There are numerous marine contractors, suitable construction equipment, and sufficient skilled labor in the Pacific Northwest and along the West Coast to execute a contaminated sediment capping project (see Appendix B for a discussion of capping technologies). Resources for the capping component of Alternative C are available from multiple vendors and are procurable through competitive bidding.

8.4.3 Cost

The costs associated with Alternative C include the capital costs associated with dredging, the construction and filling of the CDF, and sediment cap installation; the ongoing O&M costs associated with capping and the CDF;

and periodic costs associated with MNR. In addition, the integrated management of multiple contaminated sediment sites may represent a cost offset to the Terminal 4 Early Action. The predicted CDF excess capacity for sediments from other cleanup sites is 560,000 cy. The value of the excess capacity is market driven and is expected to range from $24 to $48 per cubic yard. For the purpose of the EE/CA, a value of $30 per cubic yard was assumed. Because of the uncertainties associated with the market-driven nature of this benefit, the total value was discounted, resulting in a value of about $10,000,000.

The costs associated with Alternative C are:

- Capital costs: $29,402,025
- O&M and other periodic costs: $3,027,800
- NPV (2005): $30,555,000
- NPV (2005), including excess capacity value: $20,555,000

A detailed cost estimate and relevant assumptions for Alternative C are presented in Appendix O.

8.5 Evaluation of Alternative D: Dredge Emphasis with Landfill Disposal

8.5.1 Effectiveness

This criterion addresses the ability of the alternative to meet the objective within the scope of the Removal Action.

8.5.1.1 Overall Protection of Public Health and the Environment

Alternative D meets the RAOs of reducing ecological and human health risks and the likelihood of recontamination. This alternative is expected to achieve the RAOs through a number of means, primarily by removing sediments with highest levels detected contaminants through dredging and subsequent upland disposal, by capping, and secondarily by utilizing the physical, chemical, and biological processes of MNR. Alternative D exhibits a slight recontamination potential for Slip 1 and Slip 3 where dredging is planned because of the sediment resuspension associated with dredging.

Under Alternative D, portions of the Removal Action Area will be addressed through MNR, which consists of complex physical, chemical, and biological processes, all leading to reductions in the volume and mobility of contaminants. The MNR areas have lower levels of COPCs in sediments than the capping and dredging areas and contribute only minimally to the risk of adverse effects on human health and the environment. COPCs are found at detectable levels in sediments of the MNR areas, but active removal or capping in these areas is not expected to significantly reduce risk. In addition, these areas are the most vulnerable to recontamination from upstream sources of COPCs. Based on modeling presented in Appendix H, MNR processes are expected to provide a long-term and permanent reduction in ecological and human health risk, thus providing adequate protection against those risks. The MNR areas will be monitored and, if after 5 years of post-removal action monitoring, concentrations are not consistent with RAOs, additional removal action will be evaluated. Consistency with RAOs will be based, in part, on risk-based criteria and/or cleanup goals established by USEPA through the harbor-wide RI/FS process for the Portland Harbor Superfund Site.

With respect to the other effectiveness subcriteria, Alternative D can be designed and implemented to meet the substantive requirements of the ARARs. The alternative is expected to exhibit relatively high short-term efficiency, since its primary component (dredging) may represent small risk to the community, site workers, and the environment and also because the duration of such risk is relatively short. MNR poses negligible risk to the community, site workers, and the environment. Capping is expected to exhibit somewhat less short-term efficiency, because it involves more site activities; however, its duration is short and no unacceptable short-term impacts are foreseen.

The overall protectiveness of the alternative will be further enhanced by institutional controls for areas that are capped. Proposed controls include identification of the capped areas as no commercial vessel anchoring zones. These areas would be identified on U.S. Coast Guard navigational maps. In addition, the capped areas would be identified on Port maps/plans to ensure that the integrity is not impacted during future potential construction.

8.5.1.2 Compliance with ARARs

Compliance with ARARs addresses whether a Removal Action alternative will meet the applicable and appropriate federal and state environmental requirements or whether grounds exist for a waiver. ARARs applicable to Alternative D are presented in Table 8-1.

Action-specific ARARs for Alternative D include ARARs for MNR, capping, and dredging. Chemical-specific ARARs will be addressed through implementation of the Removal Action. Location- and action-specific ARARs will be addressed through proper design, consultation with appropriate agencies, adherence to specific construction practices, and post-Removal Action environmental monitoring. Location- and action-specific ARARs are driven by the following issues:

- The majority of the Removal Action area is within the 100-year floodplain.
- In-water activities are regulated by many federal and state agencies.
- Substantive compliance with Clean Water Act (CWA) requirements, the Endangered Species Act (ESA), and Federal Emergency Management Agency (FEMA) regulations.

Alternative D is expected to comply with ARARs, and the cost of compliance is included in the estimated cost of the alternative (see Appendix O and Table 8-1).

8.5.1.3 Short-Term Effectiveness

This criterion addresses the short-term effects of an alternative during its implementation, i.e., before the RAOs have been met.

The implementation of Alternative D – including dredging in Slips 1 and 3, the processing, handling, and transportation of the dredged sediment, the treatment and discharge of decant water, the placement of sediment caps, and the sediment sampling associated with MNR – represents low to moderate risk to the community, site workers, and the environment.

Impact to the community would primarily be associated with construction-related traffic, especially if dredged sediment wastes are transported by truck for disposal at a USEPA-approved landfill. This risk would be mitigated by use of the Terminal 4 truck route (i.e., Columbia Boulevard) and by implementation of an onsite/offsite traffic plan.

Air emissions, noise, and light are not expected to affect the community beyond the effects of general conditions already prevailing at Terminal 4. Because the public does not have access to Terminal 4, exposure to contaminants and the dangers associated with specialty construction equipment is not expected. Sampling activities associated with the MNR component of the alternative are expected to have negligible impact on the community.

Potential risks to site workers from exposure to contaminants and operational hazards such as light, noise, and air emissions would be mitigated by the use of PPE as specified in a Removal Action Area-specific HASP and through the use of appropriate equipment and material handling procedures, to be specified in the design documents and the work plans. Sampling activities associated with the MNR component of the alternative will be relatively infrequent and minimally intrusive and so are expected to pose negligible potential risk to site workers.

Short-term risks to the environment during implementation of Alternative D could include:

- water quality impacts caused by the resuspension of sediment during in-water construction activities, which will be monitored by the development and implementation of a water quality monitoring plan (construction activities will be modified and additional BMPs employed in response to monitoring results, if necessary);
- operational hazards associated with on-land construction activities, including dust and air emissions from construction equipment, which will be mitigated by the use of appropriate dust control procedures and by the selection and regular maintenance of containment structures; and
- spills and accidental releases of the dredge material during dewatering, handling, processing, and loading for transport to an offsite disposal facility, which will be mitigated by devising and implementing appropriate material handling and containment procedures to reduce the potential for offsite migration of dredge material or decant water.

The schedule of construction activities associated with the implementation of the removal action alternative will be developed during the future design activities considering Port and tenant operations, infrastructure construction requirements associated with the implementation with the removal action, availability of materials, contractors, and services, as well as available in-water construction periods. Based on our experience with projects of a similar size and nature performed in the Pacific Northwest, the anticipated project duration for the removal action alternative is presented below.

The duration of the in-water activities is estimated as follows:

As described in Section 7.3.5, this alternative involves the dredging of about 204,000 cy of contaminated sediment, cap placement on about 9 acres, and MNR for the remainder of the Removal Action Area, about 11.7 acres. It is estimated that the in-water construction activities can probably be completed over two construction seasons (the in-water work window on the Willamette River is July 1 to October 31 and December 1 to January 31), with all of the dredging completed in Year 1. Impacts to the community, site workers, and the environment associated with the implementation of Alternative D are therefore limited to the relatively short time of one or two construction seasons.

The duration of the MNR portion of Alternative D is estimated to be longer, on the order of 5 years (see Appendix H). However, the short-term impacts to the community, site workers, and environment related to the MNR component of Alternative D are considered negligible.

The time needed to achieve required protection is estimated at 2 years for those subareas where capping and dredging are planned and 5 years after completion of construction for those subareas where MNR is planned.

8.5.1.4 Reduction of Mobility, Volume, and Toxicity of Contaminants through Treatment

The alternative does not involve the treatment of sediments with detected contaminants. The technology screening (Appendix B) concluded that there are no practicable treatment technologies available to treat the sediments encountered at Terminal 4. Therefore, this evaluation criterion is not considered in the analysis.

8.5.1.5 Long-Term Effectiveness

Alternative D includes significantly less capping than other alternatives. Approximately 19% of the Removal Action Area would be capped, primarily under piers and in nearshore areas of Slip 3, at the shoreline of Wheeler Bay, and at the downstream end of the Berth 401 shoreline. All capped areas satisfy ecological and human health RAOs because exposure to contaminated bed sediments by receptors of concern, or species that are components of the food web, is prevented. Mixing of bed sediment and cap material due to resuspension during placement will likely be minimal. Caps will not be constructed until dredging is complete within a given area. Therefore, the cap surface would not be impacted by sediment resuspension that may occur during dredging. Approximately 55% of the site would be dredged, including most of Slip 3 and all of Slip 1. It is anticipated that residual COPC concentrations in sediment in dredged areas will be within acceptable levels because contaminated surface sediments will have been removed to depths at which clean sediments are revealed.

The areas over which MNR will be applied are approximately the same as for Alternative B, approximately 26% of the Removal Action Area. MNR areas will be monitored for 5 years after construction is complete. Based on modeling, it is anticipated that the concentrations in the MNR areas will be within acceptable levels within 5 years after completion of the Removal Action construction. Alternative D will require the establishment of post-removal site controls, including periodic monitoring, sampling, and analyses to evaluate the progress of the MNR and to verify the long-term adequacy of the performance of the sediment caps. Corrective actions will be taken if caps fail to meet performance requirements. Should the MNR component not achieve RAOs in the 5-year timeframe, the need for capping or dredging in areas where MNR is applied would be reconsidered . MNR areas will be assessed, in part, based on risk-based criteria and/or sediment cleanup goals consistent with those developed in the harbor-wide RI/FS.

8.5.2 Implementability

The technical feasibility of the main technology components of Alternative D and the overall feasibility of the alternative are discussed in this section.

8.5.2.1 Technical Feasibility

The technical feasibility of the alternative is addressed through individual assessment of the technical feasibility of its technology components.

Dredging Component

Dredging is proposed at Slips 1 and 3 in this alternative. Dredging in Slip 3 is technically feasible. Slip 3 is an active slip where dredging has already occurred a number of times for berth deepening and maintenance purposes. Dredging of contaminated sediments has been successfully conducted at a large number of Superfund sites in the Pacific Northwest under conditions similar to those at Slip 3. In Slip 3, dredging would not face serious technical difficulties that could not be mitigated. An anticipated technical difficulty will be the relatively high volume of marine traffic at Berths 410 and 411. This difficulty can be mitigated by using high-productivity dredging, perhaps multiple dredges, to minimize the disruption of Kinder Morgan operations at Berths 410 and 411. High dredge productivity must be, however, supported with matching dredge sediment hauling capacity which may be challenging. A mechanical dredge is a likely candidate if offsite disposal of dredge sediment is selected because it produces dredge sediment with lower water content than a hydraulic dredge. Use of a hydraulic or hydraulic cutterhead dredge may require excessive dewatering and/or stabilizing the dredge sediment to meet landfill acceptance criteria. While both mechanical and hydraulic dredges are technically feasible options for offsite disposal these are often cost-prohibitive, because of the excess dewatering.

There are no time constraints with respect to dredging in Slip 1. The transload facility at the head of the slip can serve this dredging operation.

Technologies associated with the handling, transportation, and offsite disposal of dredged sediment are all considered technically feasible and proven technologies that have been implemented at several contaminated sediment remediation projects in the Pacific Northwest.

Incidental technologies, such as the collection and treatment of the decant water and discharge of the treated decant water, are also considered technically feasible, proven technologies.

Several landfills in reasonable proximity of Terminal 4 meet USEPA landfill criteria and are authorized to receive CERCLA waste. All these landfills are accessible via rail and truck, and more than one of them is accessible by barge as well. All three forms of transportation can be technically feasible for dredged sediment.

Environmental considerations, such as fish windows, climate, weather, hydraulic, and hydrologic conditions, can be incorporated into the dredging design and implementation schedule. Furthermore, the success of dredging, i.e., the removal of the contaminated sediment, can be verified through multiple methods, including real-time surveys, bathymetric surveys, and sediment sampling.

Dredging is considered a technically mature and reliable technology that is feasible for Slip 3. The technical difficulties of dredging can be addressed by design and logistical means during design and implementation of the Removal Action.

MNR Component

MNR is proposed for certain portions of the Removal Action Area including along the Willamette River harbor line (Berth 401 and North of Berth 414) and Wheeler Bay. At these locations, MNR is considered a technically feasible technology. The areas selected for MNR exhibit generally low contaminant concentrations and, as discussed in Appendix H, the physical and chemical conditions are suitable for natural recovery processes to reduce the risk posed by contamination in sediment. The progress and success of MNR are verifiable through periodic monitoring consisting of sediment analysis to verify that sediment concentrations are decreasing over time. If after 5 years of post-removal action monitoring, concentrations are not consistent with RAOs, additional removal action will be evaluated. Consistency with RAOs will be based, in part, on risk-based criteria and/or cleanup goals established by USEPA through the harbor-wide RI/FS process for the Portland Harbor Superfund Site.

Capping Component

Capping is proposed under Alternative D for a relatively small area along Berth 401, the beach at Wheeler Bay, the under-pier areas at Pier 4 in Slip 3, and over the pile area at Pier 5 in Slip 3.

The placement of sediment caps over relatively flat bottoms is a common sediment remediation technology. Numerous sediment remediation projects have successfully utilized capping in conditions similar to those proposed for Slip 1. No significant technical difficulties are foreseen for the Slip 1 capping.

The placement of a cap on the slopes in the Pier 5 area represents a technical challenge, because the slope is relatively steep. This challenge can be overcome by careful selection of a cap material with sufficient strength to be stable on the steep slope and by devising a method to place the cap to maintain its stability. This can be accomplished by scheduling the placement starting at the toe of the slope and building it in an upward direction.

In the under-pier areas, limited access represents another technical challenge. This can be overcome by selecting a synthetic cap, for example, concrete mattresses. The fabric component of the mattress can be placed with relative ease and precision, and the grout can be delivered using conventional concrete pumps.

Environmental considerations, such as fish windows, climate, weather, hydraulic, and hydrologic conditions, can be incorporated into the capping design, implementation, and schedule. A monitoring and maintenance program can also be established to verify that such effects (if and when they occur) do not reduce the serviceability of the cap, and repairs can be implemented to rectify any damage.

The success of a capping remedy is verifiable. Bathymetric and topographic surveys can be used to verify the thickness of the cap, and post-removal action confirmation samples from the cap surface can be analyzed to verify that contaminated sediment is isolated from the water and biota.

Capping is considered a technically mature and reliable technology that is feasible for this alternative. The technical difficulties of capping can be addressed by design and logistical means during design and implementation of the Removal Action.

Future Terminal 4 and Portland Harbor Actions

Overall, the alternative does not interfere with additional removal (or remedial) activities planned or anticipated within Terminal 4 or within the Portland Harbor Superfund Site.

8.5.2.2 Administrative Feasibility

Administrative feasibility evaluates those activities needed to coordinate with other offices and agencies, including statutory limits, waivers, and requirements for permits for offsite actions. Other factors that may affect administrative feasibility include the need for easements, right-of-way agreements, or zoning variances.

Statutory limits do not apply because this is a PRP-lead project. Dredging and placement of the cap material will require substantive compliance with Sections 401 and 404 of the CWA and ESA consultation. Offsite disposal of dredged material will be at a landfill that meets USEPA criteria, and off-site disposal and transport will comply with all procedural and substantive requirements and permits. If dredged material is transported by truck or rail to the offsite disposal facility, permits (for example, state solid waste permit and greenway permit) will be required for the offsite transload facility. Additionally, agreements with Port tenants will be necessary to coordinate all work for the Removal Action and in particular with a Terminal 4 transload facility and truck or train schedules. Any agreements needed between DSL and the Port for work to be done on State of Oregon land will be negotiated between the Port and DSL. Similarly, the Port will coordinate with the City for work to be conducted in Wheeler Bay, as necessary, based on the City's ownership of the adjacent upland area.

The effort and cost associated with obtaining off-site permits, meeting the substantive requirements of ARARs, and coordinating with DSL and the City, as well as coordinating with Port tenants, has been included in the cost estimate developed for this alternative.

8.5.2.3 Availability

There are numerous dredging contractors, suitable dredging equipment, and sufficient skilled labor in the Pacific Northwest and along the West Coast to execute a contaminated sediment dredging project (see Appendix B for a discussion of dredging technologies). Resources for the dredging component of Alternative D are available from multiple vendors and are procurable through competitive bidding.

Generally there are sufficient trucking contractors available in the Portland area, however, at times demand for trucking may be high and thus procuring trucks may be a challenge. Should trucking capacity become a limiting factor on production, it would be possible to combine truck transport with other technologies, such as rail or barge. The truck route currently used for Terminal 4 traffic can provide a traffic service of Level C (Port of Portland Master Plan, 2002), which is higher than the requirements (Level D) set forth by the City of Portland. Using truck haul, it is expected that the number of trucks associated with the waste hauling would not cause a deterioration of service to unacceptable levels.

For the purposes of the EE/CA, it is assumed that it will be necessary to construct a barge-to-rail transload facility at the head of Slip 1.

In the case of barge haul to a landfill located along the Columbia River, the number and size of barges need to be carefully evaluated during the design of the Removal Action. Considering that barge trafficking on the Willamette and Columbia Rivers is a long-established business, it is expected that there will be a sufficient number of barge contractors, barges, and skilled personnel available when the Removal Action is implemented.

The landfills readily available for this project have sufficient capacity and ample operational life to receive the sediment dredged at Terminal 4.

Resources needed for MNR include sampling personnel; sampling equipment; relatively small, specialty vessels; and an analytical laboratory. All these resources are readily available from multiple vendors and are procurable through competitive bidding.

There are numerous marine contractors, suitable construction equipment, and sufficient skilled labor in the Pacific Northwest and along the West Coast to execute a contaminated sediment capping project (see Appendix B for a discussion of capping technologies). Resources for the capping component of Alternative D are available from multiple vendors and are procurable through competitive bidding.

8.5.3 Cost

The costs associated with Alternative D include the capital cost associated with dredging, disposal of the dredged sediment, and cap installation; ongoing O&M costs associated with capping; and periodic costs associated with MNR. The costs associated with Alternative D are:

- Capital costs: $24,991,100
- O&M and other periodic costs: $1,743,400
- NPV (2005): $26,431,000

A detailed cost estimate and relevant assumptions for Alternative D are presented in Appendix O.

8.6 Comparison of Removal Action Alternatives

This section compares the Removal Action alternatives against each other to evaluate their relative performance in relation to the evaluation criteria (effectiveness, implementability, and cost). This is in contrast to the preceding analysis, in which each alternative was analyzed independently. The purpose of the comparative analysis is to identify the advantages and disadvantages of each alternative so that key tradeoffs affecting selection of the Preferred Alternative can be identified.

All alternatives employ a combination of removal technologies. Alternatives A, B, and D employ the same technology types (MNR, capping, and dredging), with variations in the emphasis placed on each. Alternative C uses these three technologies as well, but also involves construction of a CDF. All alternatives have some technology components in common, such as:

- dredging the bottom of Slip 3;
- capping on the side slopes of Slip 3, in a portion of Wheeler Bay, and the North of Berth 401 subarea; and
- utilizing MNR along the riverfront.

The main difference among the alternatives is how they address the sediments in Slip 1, which in turn leads to slight differences in the extent, area, or volume of sediment addressed by the above-mentioned common technology components. Since the common technology components affect the performance of all alternatives equally, the comparative evaluation of the alternatives focuses on the ways in which the alternatives differ, i.e., the difference in addressing Slip 1 sediments, and on the impacts this difference has on the other, common components as well as on overall performance of the alternatives.

For the purpose of this report, a comparison tool and procedure were adopted, as described below:

- Alternative 1 (No Action) and Alternatives A, B, C, and D were compared against each other in turn (i.e., No Action compared to Alternative A, No Action compared to Alternative B, and so on) for their ability to meet the individual evaluation criterion that make up the broader categories of effectiveness, implementability, and cost.

- For each criterion, a qualitative comparison was made between the two alternatives considered. A value of +1 was assigned to the alternative considered more favorable in terms of its relative performance at meeting the requirements of the criterion. A value of -1 was assigned to the alternative considered less favorable in terms of its relative performance.

- If the two alternatives being compared were deemed equal in their ability to meet the requirements of a criterion, both alternatives were assigned a value of zero.

This numerical comparative analysis is presented in Table 8-2.

Based on the scoring described above, an average score was then calculated for each alternative for the broader criteria of effectiveness, implementability, and cost. In addition, an overall score was calculated for each alternative. The alternatives were then ranked by overall score, i.e., the alternative with the highest score ranked first, the alternative with the next highest score ranked second, and so on.

The results of this process are shown in Table 8-2. The following section discusses the rationales behind the scoring for each of the individual evaluation criteria.

8.6.1 Effectiveness

8.6.1.1 Overall Protection of Public Health and the Environment

With regard to overall protection of public health and the environment, USEPA guidance for conducting NTCRAs states that "This discussion draws on assessments conducted under other evaluation criteria, including long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. The discussion should focus on how each alternative achieves adequate protection and describe how the alternative will reduce, control, or eliminate risks at the site…" (USEPA, 1993). The alternatives were comparatively evaluated on this basis, as discussed below.

The No Action alternative is the least protective of the alternatives because no remedy is implemented to reduce risk. This alternative would not meet RAOs and ARARs. All of the active alternatives will meet RAOs and ARARs.

Alternative C is considered to exhibit the greatest overall protectiveness because:

- The sediments with the highest concentration of contaminants will be contained in a CDF designed and constructed to be protective of human health and the environment.

- Alternative C requires the least amount of transport of contaminated sediments.

- Alternative C requires the least amount of handling of contaminated sediments.

- The construction activities associated with the implementation of Alternative C are essentially confined to the Terminal 4 facility, with little impact to the local community.

- Alternative C has the least short-term risk for recontamination during implementation because it involves moving a relatively small volume of sediment over the shortest distance and because the contaminated sediment will be isolated from the Willamette River.

- Alternative C has the least long-term risk of recontamination because it eliminates the Slip 1 sediment area.

Alternative D is considered to exhibit the least overall protectiveness because:

- It requires the offsite transport of the greatest volume of dredged sediment.

- As a result, Alternative D may most heavily impact the local community during implementation.

- Alternative D has the greatest risk for recontamination via resuspension because it includes the most extensive dredging.

Alternative B is slightly more protective than Alternative A because more sediment will be capped and thus made inaccessible to human and aquatic receptors. Both Alternatives A and B are considered to exhibit greater overall performance than does Alternative D and lesser performance than does Alternative C.

8.6.1.2 Compliance with ARARs

The No Action alternative does not comply with ARARs. All other Removal Action alternatives can be designed and implemented to meet ARARs. From this aspect of the evaluation, Alternatives A through D are considered equal.

Some alternatives may achieve compliance with ARARs more easily than others; however, compliance with ARARs is a threshold criterion under CERCLA, i.e., ease of compliance is not a factor. The effort required to meet the substantive requirements of ARARs is addressed under the administrative feasibility criterion (Section 8.6.2.2). The cost and duration of agency consultation necessary to comply with ARARs are included in the estimated costs of the alternatives (see Appendix O).

8.6.1.3 Short-Term Effectiveness

This criterion considers how the Removal Action alternatives impact the community, site workers, and the environment during implementation of the Removal Action, as well as the time needed to achieve protectiveness.

Generally, alternatives that represent the least impact to the community, site workers, and the environment during their implementation and that achieve protectiveness in the shortest time are considered most favorably.

Because this criterion incorporates four subcriteria, a secondary comparative table was constructed (see the foot of Table 8-2) for evaluating relative performance at meeting the four subcriteria, which are community protection, worker protection, environmental impacts, and length of time until protectiveness is achieved. This comparison showed that:

- The No Action alternative is the least effective in the categories of community protection and environmental impacts. Because it will not protect human health or the environment, its length of time to achieve protection is the longest.

- The No Action alternative is the most protective for workers, because no workers are required to implement this alternative.

- Of the active alternatives, Alternative C is the most protective of the community and workers during implementation, because it is limited to the site, utilizes well-established techniques (e.g., high-productivity dredging and filling), and requires the least amount of sediment handling. Alternative C will cause the least impact to the environment during implementation because the dredged sediment is moved over the shortest distance and because all filling occurs inside the CDF, isolated from the Willamette River.

- Alternative A scores second to Alternative C in limiting environmental impacts, because it relies more heavily on MNR, which requires little site activity and therefore represents little risk to the community, site workers, and the environment.

- Alternative D, which involves the most dredging, represents the greatest risk to the environment because of the potential of sediment resuspension.

- Alternative D will be the least protective of the community because dredged material will need to be transported through the community to an offsite landfill by barge, rail, or truck, increasing the potential for physical hazards.

- Alternative D involves the most construction, handling, and transportation activities and so is considered the least protective of workers.

- Alternatives A and B utilize the same techniques and methodologies and are therefore equivalent in their protection of the community and workers during implementation.

Based on the comparative evaluation, Alternative C is considered to exhibit the greatest relative performance at meeting the overall requirements of this criterion, with Alternatives B, A, and D, which present greater risks associated with sediment resuspension and sediment rehandling, showing progressively lesser relative performance.

8.6.1.4 Reduction of Mobility, Volume, and Toxicity of Contaminants through Treatment

None of the alternatives will reduce the mobility, volume, or toxicity of the contaminants through treatment and therefore all alternatives score equally under this criterion.

8.6.1.5 Long-Term Effectiveness

The No Action alternative does not reduce risk. Alternative C is considered to exhibit the greatest relative performance under this criterion because:

- Removed contaminated sediments will be placed in a CDF designed and constructed to be protective of human health and the environment.

- Alternative C will cause the least resuspension of contaminated sediments during implementation, leading to the least recontamination and the least residual risk.

Alternative D is considered to exhibit the least relative performance among the active alternatives because it represents the greatest potential for resuspension of sediments and subsequent recontamination, thereby representing the greatest potential for residual contamination and risk.

Alternatives A and B are considered essentially equal in performance. Although Alternative A involves less capping initially, additional removal action will be assessed for the MNR areas if the MNR process does not achieve sediment cleanup goals (to be established during the RI/FS process for the entire Portland Harbor Superfund Site). Therefore, Alternatives A and B are equally effective.

USEPA guidance for NTCRAs states that long-term effectiveness "also evaluates whether the alternative contributes to future remedial objectives" (USEPA, 1993). Alternatives A, B, and D contribute to future remedial objectives in the Portland Harbor Superfund Site because they reduce risk to human health and the environment. Alternative C, in addition to reducing risk to human health and the environment, further contributes to future removal/remedial activities in the Superfund Site by providing disposal options for other actions. Only Alternative C provides this additional benefit.

8.6.2 Implementability

8.6.2.1 Technical Feasibility

The No Action alternative has the greatest technical feasibility because it does not require implementation of an action.

Alternative C is the most technically feasible of the active alternatives because it employs the most widely utilized contaminated sediment management technology – dredging followed by CDF disposal. It is most compliant with the NTCRA requirement "to avoid wasteful, repetitive, short-term actions that do not contribute to the efficient, cost-effective performance of a long-term remedial action" (USEPA, 1993) because it presents a dredged sediment disposal option for other sites within the Portland Harbor Superfund Site. In short, Alternative C has the potential to contribute to the efficient, cost-effective performance of a long-term remedial action for the entire Superfund Site because it provides disposal options that are nearby, efficient, and cost-effective and that decrease sediment management and handling.

Alternative C also presents the potential for the least disruption of tenant operations, because it can facilitate the use of high-productivity dredges and the associated rapid removal of sediments from Slip 3.

Alternatives A and B exhibit comparable technical feasibility because of their similarity. Both alternatives are considered technically feasible; however, both alternatives have a somewhat higher potential for recontamination, thus potentially are less compliant with the above-cited NTCRA requirement.

Alternative D is considered to exhibit the least relative performance because it involves the dredging, handling, transportation, and disposal of the most sediment. Alternative D therefore involves the most onsite and offsite construction activities, not only those associated with dredging but also those associated with the establishment of ancillary facilities (e.g., transloading, rail or road upgrades, dewatering), as well as the greatest transportation requirements.

8.6.2.2 Administrative Feasibility

The No Action alternative is considered most administratively feasible because it would not require any permits or waivers to implement. None of the active alternatives requires an exemption from the statutory limit, because the Terminal 4 Removal Action is funded by the Port, not by Superfund monies.

Alternative D is considered to exhibit the greatest relative performance because it involves the least amount of capping on State of Oregon land and thus requires the least administrative coordination (i.e., no need for DSL negotiation in Slip 1).

Alternatives A and B are considered equal in their administrative requirements. Alternative C is considered to exhibit the least relative performance under this criterion because it impacts the largest area of State of Oregon land and may require the most administrative coordination with other agencies to facilitate construction of the CDF.

8.6.2.3 Availability

The No Action alternative has the highest ranking for availability because it does not rely on the availability of technologies, equipment, personnel, materials, or treatment, storage, and disposal (TSD) facilities.

Alternative C is considered to exhibit the greatest relative performance, because it does not involve offsite waste disposal and therefore does not rely on the availability of transport or a TSD facility (Appendix B). Alternative C also relies less on the availability of capping materials than do Alternatives A and B.

Alternatives A and B exhibit essentially the same relative performance, which is less than that of Alternative C. These alternatives rely more extensively on the availability of offsite waste disposal, transport, and capping material (Appendix B).

Alternative D is considered to exhibit the least relative performance because it relies most heavily on the availability and coordination of personnel, equipment, materials, transportation modes, and offsite TSD facilities (Appendix B).

8.6.3 Cost

The NPVs of the alternatives are:

- Alternative A – MNR Emphasis = $23,303,000
- Alternative B – Cap Emphasis = $24,627,000
- Alternative C – Dredge Emphasis with CDF Disposal = $30,555,000
    - Alternative C – Same as above, but including Excess Capacity Value = $20,555,000
- Alternative D – Dredge Emphasis with Landfill Disposal = $26,431,000

Including the excess capacity value in the NPV calculation for Alternative C places the mean cost for the alternatives within 20% of each and within the uncertainty of the cost estimates; therefore, the relative performance at meeting the cost criterion is considered equal for all alternatives.

8.6.4 Ranking of Alternatives

The comparative evaluation resulted in numerical scores used to quantify the relative performance of the alternatives. These scores, and their arithmetic averages calculated for the three main criteria of effectiveness, implementability, and cost, are presented in Table 8-2. Based on the comparative evaluation of the four active alternatives against the criteria of effectiveness, implementability, and cost, the alternatives are ranked by score in the following order:

Alternative C is ranked the highest, reflecting its greatest overall relative performance at meeting the requirements of the evaluation criteria.

Alternative B ranks second, followed by Alternative A.

Alternative D is considered to exhibit the least overall relative performance at meeting the requirements of the evaluation criteria and so ranks lowest of the active alternatives.

The No Action alternative is not ranked, because it fails to meet the threshold criteria.

Table 8-1
ARARs for Alternatives A, B, C and D

Regulation	Citation	Criterion/Standard	References
Federal ARARs			
Clean Water Act, Section 404	33 USC 1344 33 CFR Parts 320-323 40 CFR 230	Regulates discharge of dredged and fill material into waters of the United States.	Appendix Q, Draft 404(b)(1) Analysis Memorandum; Appendix O (potential BMPs, monitoring included in indirect construction cost as an aspect of design; mitigation costs).
Clean Water Act, Ambient Water Quality Criteria	33 USC 1313, 1314 40 CFR Part 131	Provides minimum standards for water quality programs established by states. Two kinds of water quality criteria exist: one for protection of human health, and one for protection of aquatic life.	EE/CA Report; Appendix J, Evaluation of Dredging Feasibility; Appendix K, Evaluation of CDF Feasibility; Appendix L, Potential Removal Action Monitoring; Appendix O, Cost Estimates (potential BMPs, monitoring included in miscellaneous construction-related direct costs; long-term monitoring costs).
Clean Water Act, Section 401	33 USC 1341	Applies to any activity which may result in any discharge into navigable waters and requires that such discharge comply with state water quality standards.	Appendix Q, Draft 404(b)(1) Analysis Memorandum; Appendix O (indirect construction cost as an aspect of design).
Resource Conservation and Recovery Act	42 USC 6901 et seq 40 CFR 260, 261	Establishes identification and management standards for solid and hazardous waste.	
Hazardous Materials Transportation Law and Regulations	49 USC 5101 et seq. 19 CFR 171-173	Requirements for transportation of hazardous materials, including classification, packaging, labeling, inspection of containers, loading and unloading techniques, training requirements.	
Fish and Wildlife Coordination Act Requirements	16 USC 662, 663 40 CFR 6.302(g)	Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways.	Appendix P, Preliminary Draft Biological Assessment; Appendix O, Cost Estimates (agency consultation and conservation measures included in design costs)
Magnuson-Stevens	50 CFR Part 600	Evaluation of impacts to Essential Fish	Appendix P, Preliminary Draft Biological Assessment;

Table 8-1 ARARs for Alternatives A, B, C and D			
Regulation	**Citation**	**Criterion/Standard**	**References**
Fishery Conservation and Management Act		Habitat (EFH) is necessary for activities that may aversely affect EFH.	Appendix O, Cost Estimates (agency consultation included in design costs).
National Historic Preservation Act	16 USC 470 et seq. 36 CFR Part 800	Requires the identification of historic properties potentially affected by the agency undertaking, and consultation to assess the effects on the historic property and seek ways to avoid, minimize or mitigate such effects. Historic property is any district, site, building, structure, or object included in or eligible for the National Register of Historic Places, including artifacts, records, and material remains related to such a property.	Archeological Monitoring Protocol for Terminal 4 site; see Appendix L, Potential Removal Action Monitoring; Appendix O, Cost Estimates (assessed during design). Given the highly disturbed condition of the RAA from prior excavation, dredging and filling, removal actions and sampling, it is not expected that historical and archeological resources will be encountered.
Native American Graves Protection and Reparation Act	25 USC 3001-3013 43 CFR 10	Requires Federal agencies and museums which have possession of or control over Native American cultural items (including human remains associated and unassociated funerary items, sacred objects and objects of cultural patrimony) to compile an inventory of such items. Prescribes when such Federal agencies and museums must return Native American cultural items. "Museums" are defined as any institution or State or local government agency that received Federal funds and has possession of, or control over, Native American cultural items.	Archeological Monitoring Protocol for Terminal 4 site; see Appendix L, Potential Removal Action Monitoring; Appendix O, Cost Estimates (assessed during design). Given the highly disturbed condition of the RAA from prior excavation, dredging and filling, removal actions and sampling, it is not expected that historical and archeological resources will be encountered.
Endangered Species	16 USC 1531 et seq.	Actions authorized, funded, or carried	Appendix P, Preliminary Draft Biological Assessment;

Table 8-1 ARARs for Alternatives A, B, C and D			
Regulation	**Citation**	**Criterion/Standard**	**References**
Act		out by federal agencies may not jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their critical habitats. On April 30, 2002, the US District Court for the District of Columbia entered a consent decree signed by NOAA Fisheries vacating and remanding critical habitat designations for certain species, including critical habitat in the lower Willamette. 68 Fed. Reg. 55900. While there is currently no designated critical habitat for fish species affecting the RAA, on December 14, 2004, NOAA Fisheries proposed to designate critical habitat for certain species of fish in the lower Willamette sub-basin. 68 Fed. Reg. 74572 (Dec. 14, 2004). The new rule may or may not affect the RAA.	Appendix O, Cost Estimates (agency consultation and conservation measures included in design costs)
Executive Order for Wetlands Protection	Executive Order 11990 (1977) 40 CFR 6.302 (a) 40 CFR Part 6, App. A	Requires measures to avoid adversely impacting wetlands whenever possible, minimize wetland destruction, and preserve the value of wetlands.	Appendix Q, Draft 404(b)(1) Analysis Memorandum; Appendix O, Cost Estimates (mitigation costs).
Executive Order for Floodplain Management National Flood Insurance Act and	Exec. Order 11988 (1977) 40 CFR Part 6, App. A 40 CFR 6.302 (b) 42 U.S.C 4001 et seq. 44 CFR National Flood Insurance Program	Requires measures to reduce the risk of flood loss, minimize impact of floods, and restore and preserve the natural and beneficial values of floodplains.	Appendix K, Evaluation of Feasibility of CDF, Attachments K-1 and K-2; Appendix O, Cost Estimates (further assessed during design).

Table 8-1 ARARs for Alternatives A, B, C and D			
Regulation	**Citation**	**Criterion/Standard**	**References**
Flood Disaster Protection Act	Subpart A Requirements for Flood Plain Management Regulations Areas		
Rivers and Harbors Act	33 USC 403 33 CFR 320-330	Regulates activity that may obstruct or alter a navigable waterway, including: (1) creating any obstruction to the navigable capacity, (2) building any wharf, boom, weir, breakwater, bulkhead, jetty, or other structure within the area of federal jurisdiction (between and below the ordinary high water marks); and (3) filling, altering or modifying the course, location, condition or capacity of the river.	Appendix Q, Draft 404(b)(1) Analysis Memorandum.
Migratory Bird Treaty Act	16 USC 703-702 50 CFR 10.12	Makes it unlawful to take, import, export, possess, buy, sell purchase, or barter any migratory bird. "Take" is defined as pursuing, hunting, shooting, poising, wounding, killing, capturing, trapping and collecting.	Appendix O, Cost Estimates (assess during design).
State ARARs			
Hazardous Waste Regulations	ORS 466.005-225, OAR 340-101-0033	Federally authorized state of Oregon hazardous waste identification and management program that operates in lieu of the base federal program. (Oregon: Final Authorization of State Hazardous Waste Management Program – Revision (September 10, 2002), 67 Fed. Reg. 57337).	TCLP testing will be performed to identify hazardous waste prior to offsite disposal. Although not expected, the Port will comply with generator requirements for any identified hazardous waste.
Oregon Hazardous	ORS 465.200-465.420;	Establishes cleanup authority and	EE/CA Report and implementation of Removal Action;

Table 8-1 ARARs for Alternatives A, B, C and D			
Regulation	**Citation**	**Criterion/Standard**	**References**
Substance Remedial Action Law and Regulations	OAR 340-122-010 et seq.	objectives, and criteria applicable to hazardous substances defined to include oil and other petroleum products. Includes authority and requirements applicable to removal actions that are patterned after CERCLA; enforces criteria very similar to those required by the National Contingency Plan to the extent they are more stringent or broader in scope than CERCLA; ORS 465.315(1)(b)(A) and (1)(e) provide standards for degree of cleanup.	Appendix M, Streamlined Risk Assessment.
State Removal Fill Law and Regulations	ORS 274.040, 0.43,.922, .944 OAR 141-85-0001 et seq; OAR 141-85-0115, 0121, 0126, 0136, 0141, 0151 and 0171	Regulates activities associated with removal and fill operations in state waters, including requirements for wetland mitigation.	Appendix Q, Draft 404(b)(1) Analysis Memorandum; Appendix O (potential BMPs, monitoring included in indirect construction cost as an aspect of design; mitigation costs).
Certification of Compliance with Water Quality Requirements and Standards	ORS 468b.035 OAR 340-048-	Defines state mechanism for certifying actions comply with water quality standards.	Appendix Q, Draft 404(b)(1) Analysis Memorandum; Appendix J, Evaluation of Dredging Feasibility; Appendix K, Evaluation of CDF Feasibility; Appendix L, Potential Removal Action Monitoring; Appendix O (potential BMPs, monitoring included in indirect construction cost).
Indian Graves and Protected Objects	ORS 97.740-760	Prohibits willful removal of cairn, burial, human remains, funerary object, sacred object or object of cultural patrimony. Provides for reinterment of human remains or funerary objects under the supervision of the appropriate Indian tribe. Proposed excavation by a professional archeologist of a native	Archeological Monitoring Protocol for Terminal 4 site, see Appendix L, Potential Removal Action Monitoring; Appendix O, Cost Estimates (assessed during design). Given the highly disturbed condition of the RAA from prior excavation, dredging and filling, removal actions and sampling, it is not expected that historical and archeological resources will be encountered.

Table 8-1
ARARs for Alternatives A, B, C and D

Regulation	Citation	Criterion/Standard	References
		Indian cairn or burial requires written notification to the State Historic Preservation Officer and prior written consent of the appropriate Indian tribe.	
Archaeological Objects and Sites	ORS 358.905-955	Prohibits persons from excavating, injuring, destroying or damaging archaeological sites or objects on public or private lands unless authorized by permit.	Archeological Monitoring Protocol for Terminal 4 site, see Appendix L, Potential Removal Action Monitoring; Appendix O, Cost Estimates (assessed during design). Given the highly disturbed condition of the RAA from prior excavation, dredging and filling, removal actions and sampling, it is not expected that historical and archeological resources will be encountered.
Requirements regarding Excavation or Removal of Archaeological or Historical Material on Public Lands	ORS 390.235 OAR 736-051-0060 to 736-051-0090	Requires permits and imposes conditions for excavation or removal of archaeological or historical materials.	Archeological Monitoring Protocol for Terminal 4 site; see Appendix L, Potential Removal Action Monitoring; Appendix O, Cost Estimates (assessed during design). Given the highly disturbed condition of the RAA from prior excavation, dredging and filling, removal actions and sampling, it is not expected that historical and archeological resources will be encountered.
State Water Quality Standards	ORS 468B.048: OAR ch 340 div 41	Provides Willamette Basin beneficial uses and establishes water quality standards and criteria to protect beneficial uses.	EE/CA Report; Appendix J, Evaluation of Dredging Feasibility; Appendix K, Evaluation of CDF Feasibility; Appendix L, Potential Removal Action Monitoring; Appendix O, Cost Estimates (potential BMPs, monitoring included in miscellaneous construction-related direct costs; long-term monitoring costs).
State Air Quality Law and Noise Control	ORS 468A OAR 340-226-0100, OAR 340-035-0035	Provides general emission standards for fugitive emissions of air contaminants and requires the highest and best practicable treatment of control of such emissions. Prohibits any handling, transporting or storage of materials, or	Appendix O, Cost Estimates (BMPs are included in construction cost estimate).

Table 8-1 ARARs for Alternatives A, B, C and D			
Regulation	**Citation**	**Criterion/Standard**	**References**
		use of a road, or any equipment to be operated, without taking reasonable precautions to prevent particulate matter from becoming airborne. Sets noise standards for equipment, facilities, operations, or activities employed in the production, storage, handling, sale purchase, exchange or maintenance of a product, commodity, or service, including the storage or disposal of waste products.	
State Essential Indiginous Salmonid Habitat	ORS 196.810(b) OAR 141-102	Designates Essential Salmonid Habitat and regulates activities affecting such habitat.	Appendix P, Preliminary Draft Biological Assessment; Appendix O, Cost Estimates (agency consultation and conservation measures included in design costs)
Lower Willamette River Management Plan	ORS 273.045 OAR 141-080-0105	Department of State Lands plan regulating leasing, license, and permit activities in the lower Willamette River. The plan describes allowable activities and conditions for waterway management areas based on state public trust values (fisheries, recreation, and navigation).	Appendix K, Evaluation of CDF Feasibility; Appendix I, Evaluation of Cap Feasibility; Appendix O, Cost Estimate (DSL costs).
ODFW Fish Management Plans for the Willamette River.	OAR 635 div 500	Provides basis for in-water work windows in the Willamette River.	EE/CA Report, Sections 8 and 9; Appendices I, J and K.
Other Criteria, Advisories, Guidance and To Be Considered Initiatives			
Willamette Basin Program	ORS 536.300, 340 OAR 690-52	Requires development of plans to maintain stream flow, promote in-stream uses and values, and meet public needs.	

Table 8-2
Comparative Analysis of Removal Action Alternatives

		Effectiveness																									
Alternative	**Description**	**Overall Protection of Public Health and the Environment**					**Compliance with ARARs**					**Short-Term Effectiveness***					**Reduction of volume, mobility, and toxicity of contaminants through treatment**					**Long-Term Effectiveness**					**Avg**
		1	**A**	**B**	**C**	**D**	**1**	**A**	**B**	**C**	**D**	**1**	**A**	**B**	**C**	**D**	**1**	**A**	**B**	**C**	**D**	**1**	**A**	**B**	**C**	**D**	
1	**No Action**		-1	-1	-1	-1		-1	-1	-1	-1		-1	-1	-1	-1		0	0	0	0		-1	-1	-1	-1	**-0.8**
A	**Alternative A: Monitored Natural Recovery Emphasis**	1		-1	-1	0	1		0	0	0	1		-1	-1	1	0		0	0	0	1		0	-1	1	**0.05**
B	**Alternative B: Cap Emphasis**	1	1		-1	0	1	0		0	0	1	1		-1	1	0	0		0	0	1	0		-1	1	**0.25**
C	**Alternative C: Dredge Emphasis with CDF Disposal**	1	1	1		1	1	0	0		0	1	1	1		1	0	0	0		0	1	1	1		1	**0.65**
D	**Alternative D: Dredge Emphasis with Landfill Disposal**	1	0	0	-1		1	0	0	0		1	-1	-1	-1		0	0	0	0		1	-1	-1	-1		**-0.15**

	Implementability																									
Alternative	**Technical Feasibility**					**Admin. Feasibility**					**Availability**					**Avg**	***Cost*** [1]					**Avg**	**Ave. Score**	**Meets Threshold Criteria (Y/N)** [2]	**Rank**
	1	**A**	**B**	**C**	**D**	**1**	**A**	**B**	**C**	**D**	**1**	**A**	**B**	**C**	**D**		**1**	**A**	**B**	**C**	**D**				
1		1	1	1	1		1	1	1	1		1	1	1	1	**1**		1	1	1	1	**1**	**0.4**	**N**	
A	-1		0	-1	1	-1		1	1	-1	-1		0	-1	1	**-0.17**	-1		0	0	0	**-0.25**	**-0.1222**	**Y**	**3**
B	-1	0		-1	1	-1	-1		1	-1	-1	0		-1	1	**-0.33**	-1	0		0	0	**-0.25**	**-0.1111**	**Y**	**2**
C	-1	1	1		1	-1	-1	-1		-1	-1	1	1		1	**0**	-1	0	0		0	**-0.25**	**0.13333**	**Y**	**1**
D	-1	-1	-1	-1		-1	1	1	1		-1	-1	-1	-1		**-0.5**	-1	0	0	0		**-0.25**	**-0.3**	**Y**	**4**

Score
1 The alternative is favored over the compared alternative
0 The alternative is equal with the compared alternative
-1 The alternative is less favorable than the compared alternative

***Short-term effectiveness**

	Protection Community					**Protection Workers**					**Environmental Impacts**					**Time Until Protection**					**Avg**	rank
	1	**A**	**B**	**C**	**D**	**1**	**A**	**B**	**C**	**D**	**1**	**A**	**B**	**C**	**D**	**1**	**A**	**B**	**C**	**D**		
1		-1	-1	-1	-1		1	1	1	1		-1	-1	-1	-1		-1	-1	-1	-1	**-0.5**	5
A	1		0	-1	1	-1		0	-1	1	1		1	0	1	1		-1	0	-1	**0.1**	3
B	1	0		-1	1	-1	0		-1	1	1	-1		-1	1	1	1		1	0	**0.2**	2
C	1	1	1		1	-1	1	1		1	1	0	1		1	1	0	-1		0	**0.6**	1
D	1	-1	-1	-1		-1	-1	-1	-1		1	-1	-1	-1		1	1	0	0		**-0.4**	4

Notes:
1. Mean cost for each the alternatives are within 20 percent and within the uncertainty of the cost; therefore, the comparison of cost is equal between alternatives
2. Threshold criteria must be met for the alternative to be acceptable. Therefore, this criteria is evaluated on a "yes" or "no" basis, with alternatives not meeting the threshold criteria being unacceptable and not included in the ranking.

9. Preferred Alternative

The Preferred Alternative is Alternative C: Dredge Emphasis with CDF Disposal. This determination is based on both the individual evaluations of the Removal Action alternatives against the evaluation criteria (Sections 8.2 through 8.5) and a comparative evaluation of the Removal Action alternatives (Section 8.6).

9.1 Description of the Preferred Alternative

Section 7.3.4 presents the main features of Alternative C. A summary of that description and additional details are provided below.

The Preferred Alternative involves the following components:

- Construction of a CDF in Slip 1. This activity will involve infrastructure relocation (e.g., movement of the barge leg), the dredging of contaminated sediment under the footprint of the containment berm (at the mouth of the slip), which will be deposited near the head of Slip 1; the placement of select material to construct the berm; and placement of sediment dredged from Slip 3 in the CDF. The CDF will have an excess disposal capacity that can be used for the disposal of suitable contaminated sediment from other removal or remedial actions within the Portland Harbor Superfund Site. Contaminated sediment from other Portland Harbor cleanup projects may be placed in the saturated portion of the CDF. Fill material will be placed in the unsaturated portion. An engineering cap will be placed over the fill to finish the CDF at-grade.

- Dredging of contaminated sediment in Slip 3 across the bottom of the slip. On the side slopes of the slip, contaminated sediment will be capped. MNR will be utilized under the Berth 410 finger pier.

- Capping of contaminated sediment along the shoreline in Wheeler Bay. MNR will be implemented in deeper areas in Wheeler Bay.

- Capping of a relatively small area in Berth 401, with MNR implemented along the shoreline.

- MNR in the North of Berth 414 area.

- Institutional controls for capped areas would include anchoring restrictions for commercial vessels; and updating Port engineering maps/plans identifying the capped areas for any planned construction projects or changes in operations to ensure the integrity of the cap is not disturbed or compromised.

- Institutional controls for the CDF would include updating engineering baseline maps/plans to include the CDF boundaries, update/include provisions in tenant leases, as applicable, formalizing notification and approval procedures for any planned construction projects or changes in operations that occur in the area of the CDF. Deed notifications or easements on the property may also be considered that would limit types of future development allowed on the CDF portion of the property.

The technologies to be used in implementing the Preferred Alternative and the areal extent to which each technology will be applied are:

Removal Action Technology	**Acres (% of Total Removal Action Area)**
Monitored Natural Recovery	10.9 acres (24%)
Sediment Capping	8.7 acres (19%)
Confined Disposal Facility	15.3 acres (34%)
Sediment Dredging	10.2 acres (23%)

Construction volumes for the Preferred Alternative are estimated as follows:

Definition	**Volume (cy)**	**Comment**
Dredge Volume	115,000	From Slip 3 and Slip 1 (10,000 cy for berm footprint)
Volume of CDF Berm	138,500	Imported clean fill
Volume of CDF Engineering Cap	255,000	Assuming a 10-foot-thick cap
Disposal Capacity of the CDF	940,000	Includes capacity utilized for Terminal 4, excess capacity (saturated), and excess capacity (unsaturated)
Capacity Utilized for Terminal 4	135,000	Sediment volume dredged from Slip 3 plus intermediate cap of 20,000 cy
Excess Capacity – Saturated (Dredged Sediments)	560,000	Assuming steady-state groundwater surface elevation across the CDF at +10 feet (CRD)
Unsaturated Zone Capacity	245,000	
Excess Capacity – Total	805,000	

9.2 Evaluation

The Preferred Alternative meets the CERCLA threshold criteria of achieving the RAOs and complying with ARARs. Section 8.4 detailed the evaluation of the Preferred Alternative (Alternative C) in comparison with the NTCRA criteria of:

- effectiveness, including:
  - overall protectiveness;
  - reduction of mobility, volume, and toxicity of contaminants through treatment;
  - short-term effectiveness; and
  - long-term effectiveness and permanence;

- implementability, including:
  - technical feasibility;
  - availability; and
  - administrative availability; and
- cost.

This section summarizes the results of the evaluation detailed in Section 8.4 for each of these criteria and subcriteria.

9.2.1 Effectiveness

Overall Protection of Public Health and the Environment. Alternative C meets the RAOs of reducing ecological and human health risks and eliminates the possibility of recontamination within Slip 1. This alternative is expected to achieve the RAOs through a number of means, primarily by removing and isolating contaminated sediments through dredging and disposal in a CDF, and by isolating contaminated bed sediments under caps. In addition, Alternative C utilizes the physical, chemical, and biological processes of MNR in areas with low levels of detected contaminants. Alternative C has a low potential for recontamination during implementation, and potential recontamination will be limited to areas where resuspension of sediments during removal activities (e.g., dredging) could occur. This alternative provides the potential to utilize certain dredging technologies that, among other benefits, can be executed with little resuspension. Appendix M (Streamlined Risk Evaluation) provides additional detail on how Alternative C reduces risk to human health and the environment. Final determination of the ability for the MNR areas to meet RAOs will be assessed within the five year monitoring period in which contaminant concentrations will be compared to the harbor-wide risk-based criteria and/or cleanup goals established for the Portland Harbor Superfund Site. Appendix N (Recontamination Analysis) provides additional detail on the process for verifying that Alternative C will meet the recontamination RAO.

Compliance with ARARs. ARARs for the Preferred Alternative (Alternative C) are presented in Table 8-1. Action-specific ARARs for Alternative C include ARARs for MNR, capping, dredging, and CDFs. Chemical-specific ARARs will be addressed through implementation of the Removal Action. Location- and action-specific ARARs will be addressed through proper design, consultation with appropriate agencies, adherence to specific construction practices, and post-Removal Action environmental monitoring.

Appendix K (Evaluation of CDF Feasibility) presents the numerical modeling of flood stage elevation and an assessment of flood storage to demonstrate compliance with relevant federal requirements related to floodplain management. The Endangered Species Act requirements will be met by preparation of a Biological Assessment (BA) and formal consultation with appropriate resource agencies. Appendix P (Draft Biological Assessment of the Preferred Alternative) provides a preliminary draft BA for the Preferred Alternative. The substantive requirements under Sections 404 and 401 of the Clean Water Act will be met by preparation of an analysis memorandum, consultation with appropriate agencies, and implementation of best management practices related to the short-term impacts to water quality. Appendix Q (Draft Clean Water Act Section 404(b)(1) Evaluation) provides a preliminary draft 404(b)(1) evaluation.

Short-Term Effectiveness. The implementation of Alternative C represents very low risk to the community, site workers, and the environment. Impact to the community would be essentially negligible because construction-related traffic would not include any sizeable amount of trucking for waste disposal, essentially all Removal Action construction-related activity would be conducted on Port property, and exposure to contaminants and the dangers associated with specialty construction equipment is not expected because access to Terminal 4 is controlled. Potential risks to site workers from exposure to contaminants and operational hazards such as light, noise, and air emissions would be mitigated by the use of PPE as specified in a Removal Action Area-specific HASP and through the use of appropriate equipment and material handling procedures, to be specified in the design documents and the work plans. Short-term impacts to the environment will be minimized by adopting appropriate control mechanisms (e.g., dust control, erosion control, turbidity curtains, and other appropriate engineering controls) and adhering to legally applicable requirements.

Reduction of Mobility, Volume, and Toxicity of Contaminants through Treatment. None of the alternatives evaluated included treatment of sediments because the treatment technology screening (Appendix B) concluded that there are no practicable treatment technologies available to treat the sediments encountered at Terminal 4.

Long-Term Effectiveness. Evaluations conducted during the EE/CA support the long-term effectiveness of the Preferred Alternative. Contaminated sediments will be removed via dredging or capped in approximately 76% of the total surface area in the Removal Action Area. It is anticipated that the residual COPC concentrations in sediment in the dredged area of Slip 3 will be within acceptable levels (to be established during the Portland Harbor Superfund assessments), because the goal of the dredging is to remove contaminated sediments, revealing a sediment surface with acceptable concentrations. Residual concentrations of COPCs in cap materials due to resuspension of bed sediment during placement are expected to be minimal. Areas over which MNR will be applied will be monitored for 5 years. It is anticipated that the concentrations in the MNR areas will be within acceptable levels within 5 years. Post-removal site controls, including periodic monitoring, sampling, and analyses to evaluate the progress of the MNR and to verify the long-term adequacy of the performance of the sediment caps will be implemented. Should the MNR component not achieve RAOs in the predicted 5-year timeframe in some or all of the areas where MNR is applied, these areas will be reconsidered. MNR areas will be evaluated based, in part, on risk-based criteria and/or sediment cleanup goals developed for the Portland Harbor Superfund Site.

Post removal action confirmation sampling and analysis will be conducted after construction to provide direct measurement of residual conditions. Corrective actions will be taken if caps or dredged areas fail to meet performance requirements.

9.2.2 Implementability

Technical Feasibility. The technical feasibility of dredging (Appendix J), CDF construction (Appendix K), MNR (Appendix H), and capping (Appendix I), which are the components of Alternative C, was evaluated. These technologies were found to be feasible for implementation in the areas of Terminal 4 designated for these technologies under the Preferred Alternative.

Administrative Feasibility. Although a variety of administrative negotiations and requirements will be needed to implement this alternative, all of the requirements can be addressed and are considered administratively feasible. Administrative requirements will include:

- administrative coordination/negotiation with DSL concerning the submerged land within the CDF footprint and capped areas;
- compliance with substantive ARAR requirements (for example, Sections 401 and 404 of the Clean Water Act and ESA consultation) needed for dredging, placement of the berm and cap materials, and discharge of sediments into the CDF; and
- agreements with Port tenants to coordinate the work for the Removal Action.

The effort and cost associated with agency interaction, meeting the substantive requirements of ARARs, and conducting consultation with DSL, as well as coordinating with Port tenants, have been included in the cost estimate developed for this alternative.

Availability. Resources for dredging and construction of the CDF (including equipment, materials, and skilled labor) are available from multiple vendors. Additionally, resources needed for MNR (sampling personnel; sampling equipment; relatively small, specialty vessels; and an analytical laboratory) are readily available from multiple vendors in the Pacific Northwest. Finally, there are numerous marine contractors, suitable construction equipment, and sufficient skilled labor in the Pacific Northwest and along the West Coast to execute a contaminated sediment capping project.

9.2.3 Cost

The costs associated with Alternative C include the capital costs associated with dredging, the construction and filling of the CDF, and sediment cap installation; the ongoing O&M costs associated with capping and the CDF; and periodic costs associated with MNR. The net present value of the Preferred Alternative is $30,555,000.

Incorporating the estimated value of the excess capacity of the CDF ($10,000,000), the net estimated cost of the Preferred Alternative is approximately $20,555,000.

Although the initial cost appears to be the highest of the removal action alternatives, incorporating the value of the excess capacity makes it the lowest cost. However, the range of cost for all alternatives is within a relatively narrow range (± $ 3.5 million from the mean cost of the four alternatives) thus at this stage of evaluation and given the uncertainty in the cost estimates (see Appendix O), Alternative C is equivalent to the other alternatives.

9.3 Implementation

- Implementation of the Removal Action will start with the design of the alternative. During the design process, progressively more detailed design drawings and specifications (30%, 60%, and 100% level of completeness) will be prepared with gradually increasing specificity in terms of areas and volumes of sediment involved; construction processes, technology and equipment, disposal facilities, and material borrow sources; and other project particulars.

In addition, a detailed Removal Action work plan will be prepared. The work plan will describe the construction activities and their schedule; procedures to protect the public, site workers, and the environment during field activities; and construction quality assurance procedures for ensuring that the RAOs and performance standards are met. Field implementation will commence after the design documents and the Removal Action work plan are approved by the USEPA.

The schedule of construction activities associated with the implementation of the removal action alternative will be developed during the future design activities considering Port and tenant operations, infrastructure construction requirements associated with the implementation with the removal action, availability of materials, contractors, and services, as well as available in-water construction periods. Based on experience with projects of a similar size and nature performed in the Pacific Northwest, the anticipated project duration for the removal action alternative is presented below.

As described in Section 7.3.4, this alternative involves the construction of a CDF involving the placement of a containment berm of 138,500 cy, the dredging of about 115,000 cy of contaminated sediment mainly from Slip 3, the filling of this material into the CDF, placement of 20,000 cy of interim capping material inside the CDF, and the placement of sediment caps over a total area of about 9 acres outside the CDF, as well as MNR on the rest of the Removal Action Area, affecting about 11 acres. Upon the completion of the filling of the excess capacity in the CDF, its final cap will be placed.

It is estimated that the infrastructure construction requirements, preparatory dredging (under the footprint of the CDF berm) and the construction of the berm, the dredging in Slip 3 and the filling of this material into the CDF, and the placement of the sediment caps can be completed in three construction seasons.

Complete filling of the CDF is expected to span several construction seasons. The total capacity of the CDF allows filling from other contaminated sediment locations in the Portland Harbor Superfund Site. After filling the CDF with sediments from Terminal 4, there is an estimated excess capacity of 560,000 cy for dredged sediments from other cleanup projects. The volume of sediment coming from other sites and the schedule of dredging, and therefore the schedule of the filling of the CDF, are not known at this time. Therefore, the overall duration of the in-water activities associated with the CDF construction and filling may span several construction seasons. However, these activities are not expected to impact water quality, since the filling of the CDF would be accomplished behind its berm, which will be designed and constructed to provide effective isolation of the filling operations from the Willamette River. As the filling of the CDF nears completion, filling rates may have to be controlled to ensure that water level in the CDF does not rise so fast that out flow of turbid water would occur.

While completing the CDF design, the Port will develop waste acceptance criteria, and a management plan for placing sediments from elsewhere in Portland Harbor. Proponents of future sediment remediation projects (including the Port) that consider disposal in the CDF will be required to evaluate the proposed sediments against the acceptance criteria and requirements of the management plan in order to consider the use of the Terminal 4 CDF as a potential disposal. It is expected that EPA will evaluate and verify that sediments intended for disposal at the CDF meet the waste acceptance criteria.

9.4 Excess Capacity

Excess capacity permanently under the water table (estimated at 560,000 cy) may be used for the placement of dredged sediment from other cleanups in the Portland Harbor Superfund Site. The suitability of the Slip 1 CDF to accommodate dredged sediment for disposal (e.g., economic viability, technical feasibility, regulatory concurrence) will have to be evaluated as part of the regulatory process for such sites with respect to the waste acceptance criteria the Port and EPA develops for the CDF.

Currently, the timeframe for filling from sources other than Slip 3 is unknown and depends on the Portland Harbor Superfund Site regulatory process (estimated at 6 years for cost estimating purposes).

9.5 Rationale for Preference

The Preferred Alternative ranks higher in effectiveness and implementability than do the other alternatives evaluated (Table 8-2; because the No Action alternative does not meet threshold criteria, it is not ranked). The cost of the Preferred Alternative, assuming the net benefit of excess capacity in the CDF, is within the same range as the costs of the other alternatives.

The Preferred Alternative will meet the substantive requirements of the ARARs and has a higher overall protection of human health and the environment than the other alternatives evaluated, because:

- The dredged contaminated sediment will be contained in a CDF designed and constructed to be protective of human health and the environment.
- The amount of handling and transport of the contaminated material is minimized.
- The construction activities associated with implementation of the Preferred Alternative are essentially confined to the Terminal 4 facility, with little impact to the local community.
- The short-term risk of recontamination during implementation is minimized because a relatively small volume of sediment is moved over the shortest distance and because the contaminated sediment will be isolated from the Willamette River by a berm.
- The long-term risk of recontamination is reduced because it eliminates the Slip 1 sediment area.

The Preferred Alternative is expected to exhibit relatively high short-term efficiency, since its main components of dredging and CDF construction represent relatively little risk to the community, to site workers, and to the environment, and the duration of these activities is relatively short. In addition, the CDF component adds a benefit because the excess capacity will provide a nearby engineered disposal option for other suitable sediments removed during removal and remedial actions within the Portland Harbor. Therefore, the Preferred Alternative has the potential to contribute to the efficient, cost-effective performance of a long-term remedial action for the entire Superfund Site because it provides disposal options that are nearby, efficient, and cost-effective and that decrease sediment management and handling.

Under the Preferred Alternative, economic values are expected to be positively impacted. Construction of the CDF will provide approximately 17 acres of land surface in the Slip 1 area. The additional land will be retained by the Port for water-dependent uses consistent with its current core marine businesses. Marine loading and offloading facilities will be modernized and relocated to the riverfront, increasing efficiency of maritime operations. Overall, development of the property will improve marine facilities along Portland's working waterfront, and strengthen the Port's competitive position and ability to support the local economy.

9.6 Summary

Based on the above considerations, Alternative C is considered to exhibit the greatest overall relative performance at meeting the requirements of the evaluation criteria and for that reason is recommended as the Preferred Alternative.

10. Recontamination Analysis of the Preferred Alternative <<RESERVED>>

This section will summarize the recontamination analysis to be performed on the Preferred Alternative identified in Section 9. This section will be provided following completion of the recontamination analysis, the methodology for which is presented in Appendix N.

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